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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE

INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Paris International Foundry Congress, 1923.

The question of an international foundry congress and exhibition was carried a step further at a meeting of the Association Technique de Fonderie de France, held in Paris on July 20. M. Ramas, who presided, stated that he had been deeply impressed as to the great benefits to be derived from international gatherings by his recent visit to Birmingham. He and his committee had not allowed grass to grow under their feet since his return, and he was happy to announce that permission had been received from the Minister for Technical Education to hold a conference and exhibition at the Ecole des Arts et Metiers (Arts and Trades School) during the second week of September next year. The advantages of such a situation, he explained, were enormous, as it would allow of a centralisation not usually afforded. For the meetings there were halls and lecture theatres of all sizes suitable alike for accommodating the largest gatherings or a small sub-committee. There were several courtyards, the largest of which would be covered in to make a fine exhibition hall, and, finally, an excellent model foundry was part and parcel of the school, where competitions for moulding would be held, the difference between the Birmingham and the proposed organisation being that the castings and not the moulds would be judged.

It was decided that invitations be sent to the foundry technical associations of America, Belgium and Britain, not merely to send delegates, but actually to hold their conferences in Paris, the exceptional facilities of the place chosen making this quite simple. After thanking M. Ronceray for carrying through the negotiations with the Ministry, M. Ramas announced that this year's congress of the French Association would open on October 5 at Nancy, and would last three days.

Whilst we cannot at this early stage make much comment on the possibilities of British foundrymen actually fixing on Paris as their Conference centre, we certainly can say that the British foundry world as a whole will appreciate the kind invitation extended to their representative technical organisation. It may be profitable to point out that if only delegates can be sent that delegation should include some influential technical educationists, as the school chosen for the Congress represents a system well worth copying in at least five centres in Great Britain.

So well designed and equipped is this school foundry that it could compete more than favourably with most industrial establishments in this country. A large moulding bay is spanned by two overhead electrical travelling cranes of 3- and 6-tons lifting capacity. Metal is furnished by a 30-cwt. per hour cupola or by variously-operated crucible furnaces. The sand-preparing machinery has been carefully chosen, and is representative of the best practice, except, obviously, conveyors and similar means for labour-saving have not been incorporated. For drying the moulds, an oven, taking a bogey wagon mounted on rails, is provided. A separate stove for cores has been installed. Moulding machines of representative types, hygienic fettling benches, a modern sand blast cabinet, and other up-to-date apparatus complete the installation. At the side of the foundry a well-equipped pattern shop is housed, whilst in the open there is plenty of room for the storage of pig-iron and moulding boxes.

We understand that there are five such foundries in the technical schools of France, but perhaps not quite so well equipped.

To visit such a school is well worth the while of any foundryman who has apprenticeship and the associated question of the future of the foundry industry at heart. On these grounds one could wish that the invitation from the French Association could be accepted.

Lantern Slides for Engineering Lectures.—Messrs. Tangyes, Limited, Cornwall Works, Birmingham, announce that they have available for loan (free of charge) to engineering lecturers and technical instructors a large and varied selection of lantern slides of their manufactures, comprising gas engines, suction gas-producers, oil engines, steam and power pumps, hydraulic machinery, machine tools, etc.: also an assortment of slides of historical interest dealing with these subjects. A list of these slides will be sent free on application. There are also available for loan a number of Papers dealing with the different classes of machinery, to assist lecturers in preparing their own papers.

XUM

Iron and Steel Institute.

Autumn Meeting.

The Autumn Meeting of the Iron and Steel Institute will be held by kind permission of the Yorkshire Philosophical Society, in the Museum Theatre, York, on Tuesday and Wednesday, September 5th and 6th. The provisional programme of the Meeting is as follows:—

MONDAY, SEPTEMBER 4th.

The Secretary's Office will be open at the Museum of the Yorkshire Philosophical Society from 5 p.m. to 7.30 for the issue of badges and programmes and for the sale of railway tickets for the excursions to Staveley and Parkgate.

TUESDAY, SEPTEMBER 5th.

At 10 a.m. the Secretary's Office will be open for the registration of Members and the issue of badges, programmes, etc. At 11 a.m. the morning meeting will open for the reading and discussion of Papers in the Theatre of the Museum of the Yorkshire Philosophical Society. The Lord Mayor of York (Alderman W. H. Birch) will welcome the Members to York. Scrutineers will be appointed for the examination of voting papers for the election of new Members and Associates.

A selection of Papers will then be read and discussed, and the meeting will be adjourned until 2.15 p.m., when the reading and discussion of Papers will be resumed.

At 4.30 p.m. Members are invited by Mr. William McConway, of Pittsburgh, to attend a film demonstration in the Theatre Royal, York, descriptive of the new McConway process for the production of steel discs by centrifugal-hydraulic methods direct from molten steel. Light refreshments will kindly be provided by their host.

The evening will be left free for Members to make their own arrangements.

WEDNESDAY, SEPTEMBER, 6th.

At 11 a.m. the morning meeting will open for the reading and discussion of Papers in the Theatre of the Yorkshire Philosophical Society.

At 3 p.m. there will be a Garden Party in the grounds of the Yorkshire Philosophical Society. Music and light refreshments will be provided, and visits will be paid under the guidance of Dr. Walter E. Collinge (Keeper of the Museum) to the ruins of St. Mary's Abbey, York, and to the Roman Wall, the Multangular Tower, the Hospitium and other Roman mediæval and modern buildings in and around the beautiful grounds of the Society.

At 8.30 p.m. a Conversazione will be held in the Art Gallery of the City of York, followed by dancing, which will commence approximately at 9.30 p.m.

THURSDAY, SEPTEMBER 7th.

This day will be devoted to visiting, by kind invitation of Mr. C. P. Markham and the Directors of the Company, the Devonshire Works of the Staveley Coal and Iron Company, Limited, near Chesterfield.

At 7.45 p.m. for 8 p.m. Members will dine together informally in the Assembly Rooms, Blake Street, York.

FRIDAY, SEPTEMBER 8th.

This day will be devoted to visiting, by kind invitation to Mr. C. P. Markham and the Directors of the Company, the Works of the Parkgate Iron and Steel Company, Limited.

Papers to be Read at the Meeting.

The following is the list of Papers which it is expected will be submitted at the Meeting:—

The Changes of Volume of Steels During Heat Treatment. (1. Air Hardening Nickel Chromium Steels), by L. Aitchison.

Nitrogenisation of Iron and Steel by Sodium Nitrate, by L. E. Benson.

A Brinell Machine Attachment for Use with Small Specimens, by E. D. Campbell.

A Preliminary Magnetic Study of Some Heat-treated Carbon Steels, by E. D. Campbell and — Johnson.

Some Experiments on the Flow of Steels at a Low Red Heat, with a Note on the Scaling of Heated Steels, by J. H. S. Dickenson.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands, by C. W. H. Holmes.

Practical Notes on the Manufacture and Treatment of High-speed Steel, by H. K. Ogilvie.

The Bases of Modern Blast-Furnace Practice, by A. K. Reese.

Reversing Cogging Mills; Their Drives and Auxiliary Equipment, by G. A. V. Russell.

The Diminution of Lag at Arl through Deformation, by J. H. Whiteley.

German Iron Foundries.

The Association of German Iron Foundries (Foundry Union) of Düsseldorf reports that the activity of the foundries in the second quarter of 1922 was satisfactory in all parts of the country. Further large increase in the prices of raw materials and in wages and salaries had taken place. At the beginning of the quarter a certain amount of holding back was perceptible among customers in placing orders, but towards the end there was a brisk flow of orders. The foundries, however, were unable to develop their full output capacity owing to the growing scarcity of raw materials and the migration of workmen from the foundries, particularly into the building trades; and the places left vacant by them could only be filled partially by fugitives from Upper Silesia. Certain foreign countries were entirely out of the question for exports, as the import duties levied by them were higher than the German inland prices, and it was only possible to increase the exports materially to the East.

In the Western district the wage movements are assuming a more pronounced form. The degree of activity in the Saar is satisfactory upon the whole, and frequently good, and the supplies of pig-iron and coke are adequate. The wages there continue to increase, and as a consequence of the high costs of production the Saar foundries are more and more losing hold of the German market, causing them to seek trade abroad. The favourable situation in South Germany in the first three months was continued in the second quarter, this being attributed to the accumulation of orders during and after the strike. The wages paid in this district and in the West are the highest in Germany. In North and Central Germany the supplies of raw materials were less satisfactory, and continuous working was only maintained with difficulty, Northern Germany being more readily supplied with raw materials from England.

The Association states that it is doubtful whether the rate of activity in the coming months will be satisfactory, the principal question being the better and more regular delivery of raw materials. It is hinted that foreign pig-iron will provisionally have to be imported on a larger scale than hitherto.

Personal.

The late Mr. J. H. Osborne, of the Shanghai Dock & Engineering Company, Limited, left £4,385.

The late Mr. W. Lowe, managing director of Dean & Lowe, ironfounders and engineers, left £10,893 gross and £8,760 net.

Mr. A. Reichwald, of Reichwald, Limited, Finsbury Pavement House, E.C., who died on April 8, has left estate of the value of £46,325.

The late Mr. G. Wordsworth, of Thurgoland, near Sheffield, governing director of George Wordsworth & Sons, Limited, wire manufacturers, left £8,034.

The late Mr. Edward Vaughan Morgan, of Messrs. Morgan Bros. and the Morgan Crucible Company, left estate of the gross value of £316,884, with net personalty of £315,831.

Mr. W. T. Bell, managing director, has been elected chairman of the board of directors of Robey & Company, Limited, Lincoln, in the place of the late Mr. Alexander Trotter.

Mr. D. M. Mackay, a director and manager of Messrs. David Colville & Sons, Limited, of Motherwell, a director of the Clyde Alloy Steel Company, Limited, and of Smith & Maclean, Limited, left personal estate in the United Kingdom valued at £107,056.

An Apprenticeship Course in Foundry Practice.—III.

By Ben Shaw and James Edgar.

(*Continued from page 74.*)

Stacking Timber.

In a previous article the statement was made that it is too often forgotten, by patternmakers, that timber is stacked or racked to season it. It is always difficult to get journeymen, as well as apprentices, to realise the importance of replacing boards in the racks after they have sawn off required lengths. Broadly speaking, there are three methods of storing timber. It may be stacked in an almost vertical position, as shewn in Fig. 1; racks may be made to support the timber resting on edge, as shewn in Fig. 2; or the boards may be placed on top of each other, like Fig. 3. In small shops it is a common custom to store the timber in a corner of the shop. If it is kept in the open air, then it should undoubtedly be stacked as in Fig. 1, and the short lengths put in special racks in the pattern shop. This form of timber stack is usually erected outside but within convenient reach of the pattern shop. The rack should be covered, the roof being supported on columns leaving the sides and ends open, and it should be located over a prepared cinder bed to ensure drainage.

The rack, consisting of four frames placed about three feet apart and tied together, is a very satisfactory method of keeping timber that is already comparatively well seasoned. A rack like this does not occupy more space than placing the boards on top of each other, and, if sections are allotted to different thicknesses, both time and labour is saved. When timber is stored as shewn in Fig. 3, strips are placed between the boards in order to allow air to circulate about them, and thus complete the seasoning. The objection to this method, however, is that it takes up much space, and that, even if different thicknesses are filed separately, it may be necessary to turn over many boards before a satisfactory one, for the purpose required, is obtained.

Plywood.

Plywood is not greatly used in pattern shops. The only purpose for which it might be used is for making ribs, either for patterns or core-boxes, but it is inadvisable to use it, even for this purpose, because, when the work comes into contact with the damp sand, the glue invariably softens and the layers of timber come apart. In some shops it is used for drawing boards, and it is, within limits, suitable for the purpose. It is light, therefore easily handled, which is an advantage with large boards, and, as only hardwood is obtainable as plywood, a neat drawing is obtained. The disadvantages are that care must be taken that such drawing boards must not be left in foundry yards—no drawing board should be for that matter—nor must they be left adjacent to foundry stoves; another disadvantage is that it is not possible, as with an ordinary drawing board, to unscrew the battens, take the board to pieces and clean off an old drawing board at the planing machine.

Glue.

The preparation and use of glue deserves more attention than is given to it in most pattern shops. Glue should always be regarded as a necessary evil. It should never be used unless patterns are to be painted and varnished; indeed, in all but very exceptional cases, its use should be regarded as a temporary expedient to hold the work together while being turned or carved. Good-quality glue is essential for patternmaking. Very little fish glue is used for this purpose. The best known glues are obtained from hides, but bones and other animal skins provide glue. Glue has also been manufactured recently from leather waste. Its desirable characteristics are:—(1) Strong adhesiveness; (2) tenacity, which is slightly different from adhesiveness, and which may be defined as the power to resist the disruptive effect of a stress in any direction. This, however, is not as important in patternmaking as in aircraft construction. (3) Elasticity or the power to stretch slightly without fracture; and (4) it should possess practical working qualities.

Thick shellac varnish is occasionally used as an adhesive for broken corners, affixing brass letters, and small leather fillets. It may be stated, as a general rule, that animal glue in sheet or flake form is practically the only glue used in the pattern shop. There are patent liquid glues on the market which are very satisfactory, but they are not used for general work, because of the cost. The best results are not obtained from glue which is boiled directly after it is broken up. The proper way to prepare it is to break the cakes into small pieces, then put a quantity into a soaking pot full of cold water. With ground glue, which is seldom used in pattern shops, a soaking of 15 to 20 minutes is sufficient; flake glue needs 10 or 12 hours; while thick cake glue is not injured by 24 hours' soaking. It is bad practice to keep a large quantity steeping and simply replenish as some is taken out of the soaking pot. Burnt glue should always be thrown away, as its adhesive power is impaired. It should also be remembered that glue is strongest when freshly prepared, therefore it is better, when only a small quantity of it is used, to keep a glue pot half full; this also ensures it being clean. In a large shop three or four pots should be kept hot in the steam chest, with a spare pot full of clean hot water. Too high a temperature spoils glue. It should be heated to approximately 140 deg. Fah. (60 deg. C.), and it ought always to be used when hot.

Glueing work is never satisfactory in a cold or damp workshop. The faces of timber to be glued should, if the shop is cold, be warmed to prevent the glue chilling. For end grain thick glue is necessary, and a preliminary sizing coat is an advantage, but glue of a thin consistency is best for most purposes. Many factors enter into glueing. Surfaces should be dusted before the glue is spread, glass paper should never be used to scratch the surfaces, as this fills the pores, and, for the same reason, chalk should not be used when forming joints. All joints should be "rubbed," that is, the superfluous glue and air should be pressed out of them, but care should be taken not to overdo the rubbing. Both faces of a joint should be spread with glue, and it is advisable to leave glued work for 10 or 12 hours before placing a strain upon it.

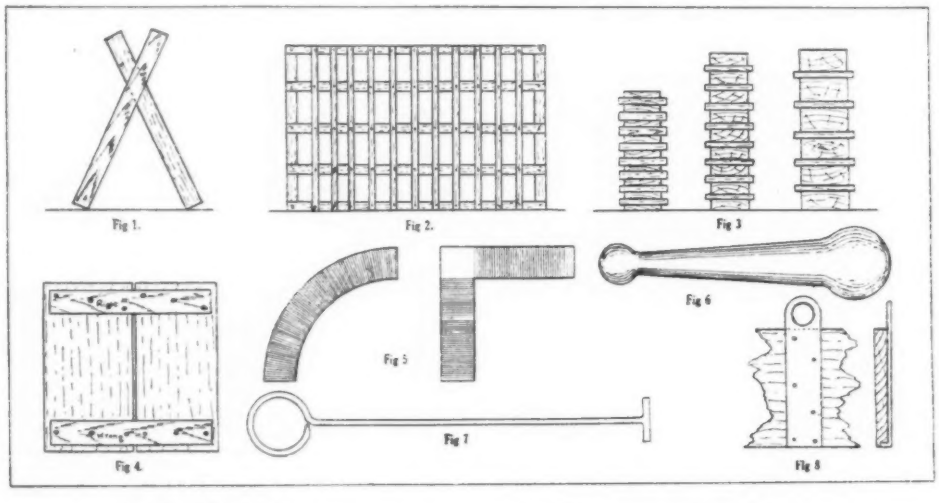
Brushes should not be left in the glue. A good joint cannot be made with a brush which is shedding hair, and, to prevent this, and prolong the life of the brush, it should be allowed to soak in clean water when not in use. Finally, it should always be remembered that it is futile to glue wet timber, to use burnt glue, or thick and cold glue, which simply forms a layer between the two timber faces.

Nails and Screws.

There is an increasing prejudice against the use of nails in some shops, but the practice in other shops of not using them for any purpose whatever is just as foolish. Wire nails and sprigs are satisfactory for segmental work, for fastening ribs, and many small facings and bosses. Care should always be taken to dovetail, unless it is impossible because of the thinness of the work. With regard to "grip"—we are using workshop terms—this depends on the thickness of timber and on the length of nails being used. When fastening down ½ in. timber, sprigs 1¼ in. long should be used; but if the timber is 1½ in. thick, nails 2½ in. long would, in most cases, suffice. In all cases sprigs and other driving nails should be punched down. Oval wire nails are more satisfactory for most purposes than flat-headed nails. Some patternshops—very few, fortunately—use wire nails largely for core-box construction and "clinch" them; that is, if the two thicknesses to be fastened together make 2 in., longer nails are driven through and the ends knocked over. This is not only a clumsy job, but seldom satisfactory. The use of panel and veneer pins are particularly suitable for small intricate work.

As a general rule, screws, though less economical

than nails, are preferred, not only because they give better security, but because they can easily be removed when they come in the way of tool operations and when the pattern needs to be altered. With regard to the "grip" of screws ½ in. is sufficient, excepting when the screw is over 2½ in. long, and then ¾ in. should be allowed, and, in very large sizes, 1 in. Screws are seldom satisfactory for end grain, but nails are a bad substitute; this is one of the difficulties with which patternmakers have to contend, that may, on occasion, be overcome by skilful construction. When using screws, the holes in the top thickness should always be bored to allow the screws to be pushed through without the aid of a hammer. Under no circumstances should screws be hammered through the top thickness; the fibre is, in this way, bruised, and if the timber does not split at the time it may ultimately do so. Screw heads should be flush with the surface of the wood, or very little under, excepting when the screw is to be removed by the moulder; then a cheese-headed screw, with the head partly projecting from the work, is preferable. It is not good practice to insert screws a short distance apart, and on the same "line" of the grain. Fig. 4 illustrates the correct way of screwing battens on a board, and this method is applicable for much other work.



Paint and Varnish.

There are a number of patent lacquers and enamels on the market now specially prepared for the patternmaker, but some do not give satisfaction, therefore, many still prefer to mix paint and varnish for themselves. Many of these special varnishes are made from ordinary varnish gums which are not available for patterns. What is required is a genuine shellac varnish without the admixture of gums or quick driers. Some firms do supply a reliable varnish of this description. These varnishes are superior to those made in the shops, because they are filtered and they have time to mature, and there is no waste of time and material in their preparation. Red-lead paint is invariably used on medium-sized and sometimes on large work, and the coated surfaces are afterwards varnished. Some books on patternmaking mention copal varnish, but it is very seldom indeed that it is seen in the pattern shop. It dries very hard and is very satisfactory, but it takes too long to dry. Shellac varnish is invariably used, and it is a thoroughly satisfactory protective coating. It should be remembered that the object of coating patterns is not merely to give them a smooth and glossy finish, to facilitate withdrawal from the sand, but to protect them from the varying temperature conditions of the foundry and to cover glued joints. The best flaked orange shellac dissolved in methylated spirits makes a reliable varnish. The shellac should be just covered with spirit and allowed to dissolve. The varnish pot should always be covered, and if the varnish becomes dirty a little oxalic acid will clarify it. Some pattern shops paint core-prints and machined surfaces in special colours. For this purpose colouring matter is introduced into the varnish, either lamp-black, drop-black, or aniline black being used for black varnish; orange lead, vermilionette, or Bergen's vermilion for red varnish. These are the colours most commonly used, but pigments or aniline dyes can be obtained for any colour desired. Some patternmakers use the coloured varnish for distinguishing between the metals of which the castings are to be composed; it reduces the possibility of error at the foundry. Varnish should be applied sparingly with a soft brush. Two or three coats are necessary, and the varnish is better thin than thick. The surface should be sandpapered smooth after each coat.

Fillets.

Fillets are necessary on patterns to prevent irregular crystallisation of the metal in the castings. When drawings are supplied with sharp corners the patternmaker or moulder rounds and fillets, unless it is specially desired that a corner be cast sharp, knowing from practical experience that it reduces the tendency to fracture. Sharp corners also tear the mould and prevent the easy delivery of the pattern. The crystals form at right angles to the face of the mould, and when the junction between pieces, at an angle to each other, is filleted, a stronger casting results than is likely when the corner is made sharp. Fig. 5 shows clearly what is meant. Fillets are best cut from the pattern block. Wood fillets are better than lead; they are made in straight lengths, and are only suitable for straight work. They should be glued, sprigged and afterwards well sand-papered. Wax fillets are quite good, but leather fillets are undoubtedly the best loose fillets. When properly fastened with glue of medium consistency and the surface rubbed with a dumbbell tool like that shown in Fig. 6, a very satisfactory job results. Leather fillets can be used on concave and convex surfaces. No nails should be used, but, if the pattern is not to be varnished, it is necessary that it should be sprigged, otherwise it will curl off in the damp sand.

Use of Glasspaper.

Too much glasspaper is used in pattern shops. For irregular surfaces it is almost indispensable, but it should not be used on planed surfaces, as, even if a good rubber is used, it renders level surfaces uneven. Under no circumstances should sandpaper be used to grind work to shape, as accuracy cannot be attained in this way. Apprentices—and journeymen—use sandpaper when turning, very often, as a substitute for sharp tools.

Lead Rivets.

Rivets made of lead have a very real value in the pattern shop. They are used for securing the joints of thin framed work, and also when thin plates are required in two thicknesses. They are used in preference to screws when the grip of the screws would be so small as to render them almost valueless. The rivets are made from lead wire from ⅛ to ¼ in. in diameter. Holes are bored and countersunk on each side, pieces of wire a little

longer than the thickness of the two pieces of wood are introduced and riveted. These rivets can afterwards be planed with the wood without any apparent effect upon the blade.

Rapping and Drawing Plates.

A great deal could be written about pattern-drawing methods, which are equally the concern of the patternmaker and the moulder. All but the smallest patterns should be fitted with plates, otherwise the moulder has no alternative but to hammer a spike into them, which is a very destructive practice. A point to be considered in locating drawing plates is that when the pattern is suspended from them, it balances. It is well to bore holes in the pattern underneath the holes in the plate, but larger, so that no harm can be done when the lifting or rapping rod is inserted. For deep lifts the plates should, if possible, be set into the underside of the pattern or the plate screws may strip. Plates usually have one hole screwed for the lifting rod, and the other drilled for rapping. For very large work a keyed end on the lifting rod is sometimes substituted for a screw, as in Fig. 7. The plate for this rod has a rectangular hole through the centre, and, when the rod is inserted, only a quarter turn is necessary to take hold. With small patterns the lifting rod is sometimes used for rapping, but this rapidly destroys the thread. When the pattern is to be deep in the sand, and its thickness prevents the use of a lifting rod, lifting straps, such as is shown in Fig. 8, should be attached before the pattern leaves the pattern shop. These are usually made from hoop iron from 1½ in. to 2 in. wide and from ⅛ in. to ¼ in. thick.

Dowels.

Dowels may be made of wood or metal. If made of wood, they should not be more than ½ in. or ⅝ in. long and shorter for ¼ in. and ⅜ in. dowels, and they ought to be tapered almost from the face of the pattern. They should not be "tight" when the top half of the pattern is placed in position, nor yet should they be slack. The objections to wooden dowels are that they swell and invite the attention of the moulder's pocket knife, and the holes became filled with sand, which is not easily removed without damaging the hole. Wooden dowels should be made of hardwood. Metal dowels are coming more into general use, these being made of brass or iron. Both socket and dowel are usually tapped or screwed into holes bored in the parts, thus, for small work they are more suitable than iron plate dowels. Plate dowels are made rectangular, circular, and, what may be termed double circular, and in various sizes. A point in their favour is that they never get loose.

Pattern Letters and Figures.

These are made in Roman and Gothic styles. The "Maughlan" letters, which were shown in this journal a few months ago, are very satisfactory. Small letters may be fastened with shellac and larger ones with nails. In some shops lead letters are cast as required in iron moulds. Roman letters are bolder, but the sharp Gothic give less trouble to the moulder as they leave the sand readily. For fastening small brass letters, burnt shellac is the best adhesive; it is made by burning the spirit out of shellac varnish. Incidentally, this adhesive is very suitable for patching small corners broken from patterns.

Metal for Patterns.

The use of metal in the formation of patterns has considerably increased during recent years, especially for standardised work. Very complicated designs can be satisfactorily formed in metal; it maintains its shape better than wood, and ensures a cleaner withdrawal from the sand. It is only suitable when very large quantities of castings are required however, and when there is no possibility of alterations. Quite a variety of metals are used, depending upon the shop methods. Iron, brass, bronze and white metals are used. Close grained grey iron, such as is used for light machinery castings, is very suitable. To prepare iron patterns for moulding, they should be rubbed over with a sal-ammoniac solution and allowed to dry. After being thoroughly rusted a wire brush is applied vigorously over the surface, and a coating of wax applied. To do this the pattern is heated, the wax warmed, and the coating put on with a soft brush; the surface being afterwards smoothed. Sometimes when a wood pattern is sent to a foundry from which many castings have to be made quickly, a few iron patterns are cast. This practice is only possible with small and comparatively rough work, because of contraction difficulties. An alloy of equal parts of tin and zinc has small shrinkage, about $\frac{1}{16}$ in. to the foot, and is therefore very suitable for work like this. A harder alloy consists of 85 per cent. tin and 15 per cent. antimony. Aluminium patterns are used considerably for internal combustion engine work.

Wire.

A description of patternmaking materials would not be complete without some mention of wire. On some patterns many ribs, and other parts, have to be left "loose," that is, located in their correct positions firmly, yet so that they can be left in the sand, when the moulder draws the main part of the pattern. Sliding dovetails form the best temporary fastenings, but, when it is not practically possible, or, when one or two only are required, wire, sprigs, or screws are employed. Sprigs are objectionable because of the difficulty in withdrawing them, and screws are only suitable when the "loose" part is so situated that the moulder can use a screw-driver freely, after sand has been tucked round the part, and there is no danger of it being moved. Wire is most serviceable, because a suitable hole must be made previous to its insertion, and also because a grip can be made at the end. Copper wire is best, and the gauge should depend on the size of the work. When all is said that can be said for wire sprigs and screws, they should only be regarded as unavoidable makeshifts, and bad substitutes for dovetails. Sometimes loose pieces can be checked into the main body of the pattern or the core-box, and this alone suffices, and, occasionally dowels answer the purpose. Dowels are very satisfactory.

Other Materials for Pattern-making.—Although metal patterns are frequently made, the patternmaker is essentially a woodworker, but there are also other materials of which patterns are sometimes made. We need not mention sand patterns here, but rubber is sometimes, although very seldom, used for small patterns. Plaster of Paris is largely used in the light casting industry, but not very frequently in engine shops, and of lead the same may be said. Some pattern-makers have sought to use sawdust by mixing it with plaster of Paris or other cement, such "artificial" woods not usually proving economical, even if comparatively successful. A new proprietary article has recently been placed on the market which is, within limits, a very useful material in the pattern shop. We refer to "Necol" plastic wood. It is a material having a consistency like dough, and can be moulded into any form, drying hard when exposed to the air—a sort of artificial wood without grain. We do not think it will ever be much used for pattern construction, but it is useful for filling holes, forming fillets, and making up broken corners. When old castings are used as patterns, making-up pieces for machining and contraction have either to be fastened to the old casting or supplied to the moulder to bed into the mould, and plastic wood has proved very successful for this work, as it adheres to metal surfaces equally as firmly as to wood.

DEALING with the future trade position at the meeting of Vickers, Limited, Mr. Douglas Vickers, M.P., analysed the position of the investor. Engineering products, he pointed out, were purchased almost entirely on capital account, and paid for either out of profits retained in the business or sums raised by new capital. While excessive taxation had almost put a stop to the former there was little attraction to investors to put money in plant at present prices in view of the return obtainable on trustee securities. Mr. Vickers suggested that advantage could be taken of the attitude of the investor by granting a Government guarantee to loans raised for developing the Empire overseas.

Some Notes on Foundry Organisation.

By H. W. Ross.

The installation of foundry equipment must be backed by good administrative services, the close association between these two points is not generally accepted, hence one often finds new plant put to work under unfavourable conditions and giving results far below those rightly claimed by the manufacturers.

It is essential that the work is fed to machine and hand operations in a predetermined and systematic manner, and, to attain this, orders and instructions must be issued to all departments, giving all requisite information, so that work can be planned out and delays eliminated.

A further important point is the number of hours per day that such machines can be kept producing. "Waiting time" must be kept down to a minimum. This source of loss is always a serious item in a foundry and is most ably described in detail in "Maximum Production in Shop and Foundry," by Knoeppel.

It is not suggested that the methods described in this article will cut out the loss of "waiting time," or be applicable to any foundry; local conditions must always be taken into consideration. It is, however, hoped that it will materially assist those foundrymen who have experienced difficulty in the issuing of orders, controlling work in the shops, ability to make promises of delivery upon which clients can rely.

A further consideration is that of costs, in which foundrymen are vitally interested. To enable the cost office to carry out their duties, it is necessary that they are closely linked up with the foundry, and it will be noticed that the methods under review cater for this in various ways.

The conditions found in the foundry where this system worked, called for the classification of all orders into trade groups, which represented the class of work, for which cost accounts were kept and compared from time to time. These groups were coded for reference purposes, as under:—

Automobile	S.A.
Engineering—plain	S.E.
,, medium	S.G.
,, intricate	S.H.
Railway	S.R.
Patterns—chargeable	S.P.

Series of numbers were also allotted to each group so that when orders were filed in numerical sequence the division by groups was automatically obtained.

The classification of orders received must, of course, be undertaken by a practical man, for preference the foundry manager, who would affix to the customer's order a slip, as "Form A," and fill in the code group and information relating to patterns.

The customer's order, together with the "Information Slip" (Form A), is then passed to the Order Department, who enter it on a "Daily Report of Orders Received" (Form B). This report is made out in duplicate, a separate report being used for each group. Consecutive numbers are allotted to each item of a customer's order: this latter rule may appear to be unnecessary or extravagant, but after having seen several other systems it was decided that this method was the only practical one to give the desired results under the conditions existing. One copy of this report is filed in an Order Register, thus acting as a direct reference to client's name by Order Number. The duplicate is passed to the foundry office, who fill in estimated weight, price, and value. These are summarised daily, so that the accumulative totals of both weight and value is always obtainable. Such information should always be charted, showing accumulative totals, comparisons between this month, last month, this year, last year, and will be of great value to both the sales and foundry managers.

From the customer's original order, the Order Department type Sales and Production Order sets (Form C), separate sets being used for each order number, *i.e.*, each item of a customer's order.

Any alterations made after the issue of such sets, such as price, quantity, delivery instructions, should be advised to all departments by the circulation of additional sets under the same group and order number; such sets should be distinctly stamped "*rectification only.*"

Sales Orders.

These consisted of copies for: (*a*) Order department; (*b*) cost department; (*c*) despatch department; (*d*) accounts department.

(a) *Order Department.* This copy is filed vertically under client's name, thus forming a cross-reference to the order register.

(b) *Cost Department.* This is filed numerically, *i.e.*, under groups, and used where necessary for opening up job cost accounts and general reference purposes.

ORDER DEPT. INFORMATION SLIP.

CLIENT:

CODE:

GROUP:

Patterns to be—

Altered / Made / Purchased } and charged to Clients.

REMARKS:

FORM "A."

(*c*) *Despatch Department.* This is filed in a box file, in alphabetical order, representing "Orders on Hand." All deliveries are recorded on the back of this copy, showing:—

Date—Advice No.—Quantity—Accumulative Total.

As the total quantity called for is despatched, these copies are transferred to an "Order Completed" file for future reference.

(d) *Accounts Department.* This is filed numerically, representing "Orders on Hand." As invoices are made out from the Advice Notes, particulars as to prices, terms, etc., are obtained from this copy of the order, and the following information entered on the back:—

Date—Invoice No.—Quantity—Weight.

In a similar manner to copy (c) which are transferred to a completed order file.

Provided all invoices are made out to date, the Orders on Hand of the despatch department should agree with those of the accounts department, and this check should be done monthly.

DAILY REPORT OF ORDERS RECEIVED.

Class Date

S. O. No.	Client.	Weight.	Rate.	Value.

FORM "B."

Production Orders.

These consisted of copies for: (*e*) Pattern shop; (*f*) foundry office; (*g*) moulding department; (*h*) inspection department.

(e) *Pattern Shop.* This copy is only a requisition to the pattern stores to supply the moulding department with the necessary patterns and core-boxes. The receipt of such does not act as author-

ity for the making or alteration of patterns, this being catered for by: (*a*) Issue of a special set of orders for all work chargeable; (*b*) verbal instructions at a daily meeting held by foundry manager in the case of alterations chargeable against the foundry.

The patterns were labelled with the production order number and delivered to the moulding department, and this copy of the order sent to foundry office, thereby automatically advising the latter of orders ready for production.

(f) *Foundry Office.* This is the master order record of the foundry and is filed on receipt alphabetically. On receipt of (copy *e*) from pattern shop, the date of receipt is recorded on the back; also the following information obtained during the progress of the order from daily reports:—

Date—Heat No.—Quantity Cast—No. Scrap—Accumulative Total of Good.

No. Scrap on Inspection—Nos. Welded—Nos. for Recast.

Supplementary Orders Issued, No. and Date. Nos. Delivered to Despatch—Unit Weight.

The routine of the foundry office, in addition to the above, is briefly (1) to issue to foreman moulder (copy *g*), referred to later, on receipt of pattern shop (copy *e*), thus advising that the job is ready to be put in hand (2) to enter on foundry office copy records of all quantities cast, and whether scrap or good; (3) to enter all castings scrapped by the inspection department and numbers passed through for despatch; (4) to issue supplementary orders for all castings required to replace shop scrap.

(g) *Moulding Department.* This copy is sent direct to foundry office and filed by them for the use of the foreman moulder, who is thus advised of work coming along, and can consult with the pattern shop regarding any alteration in methods of manufacture.

As the pattern shop copy is received, the moulding department copy of the same order is transferred to a "*Work in Hand*" file and passed to the foreman, who uses this for issuing work to the shops. This copy is arranged to record moulder's check number, date and quantity moulded.

(h) *Inspection Department.* This copy is issued direct to the inspection department for informing them of any specific tests to be carried out, and provide necessary data for making out inspection reports.

Patterns Chargeable.

A common difficulty experienced in the foundry is charging out new patterns or pattern alterations, which are often retained by the foundry against future orders, and consequently do not pass through the despatch department. To cater for this, a separate set of Sales and Production Orders can be issued for all new patterns or alterations chargeable. These are similar to Form C, except that no copy is sent to the inspection department.

The sales orders are treated in a similar manner to that previously described, except in the case of the despatch department, who retain the copy until the castings ordered in connection with the pattern had been despatched. In such a case the copy of the pattern order is transferred to a file for "Patterns for Despatch." This file was periodically gone through by the foundry manager, and, where considered necessary, instructions are issued for their return to customer.

Production Orders.

The pattern shop copy is this department's authority for proceeding with the work, and when completed is sent to the foundry office together with the copy of order for the castings required from such pattern. On receipt of these two copies the foundry office sends the former direct to the

c 2

ACCOUNTS DEPT. COPY. No. 11 — **SALES ORDER.** — TO BE FILED NUMERICALLY.

Client's Order No.	L. O. Ref.	Client			Cost Symbol	Order No.
Client's Drg. No.	Date Retd.				Order Comprises	Date
Pattern No.	Core Box No.	Terms	Carriage	Patt. Retd. (Date)	Advice No.	Quotation No.
Quantity	Description				Remarks	
Delivery Required						
Delivery Instructions						
	Price					

FOUNDRY OFFICE COPY. No. 12 — **PRODUCTION ORDER.** — TO BE FILED FIRST NUMERICALLY AND AFTER TRANSFERRED UNDER CLIENT'S NAME.

Client's Order No.	Drawing No.	Client	Cost Symbol	Order No.
Pattern No.	Core Box No.		Order Comprises	Date
Quantity	Description		Quotation No.	
			Delivery Promised	
Tests Required				

FORM "C."

accounts department, and the latter is treated as previously described under the heading of (f) *Foundry Office*. By such means the accounts department are able to pass charges through the books, holding up the actual invoice until a consignment of castings is invoiced. The copies for foundry office and moulding department are filed with the order for castings, thus intimating by their presence the reason of delay.

Delivery Promises.

The orders in hand, as shown by the foundry office copies, are examined daily, and in the majority of cases a promise for delivery settled at the daily meeting, whether requested by customer or not. The information so obtained is recorded on "Form D," copies being sent to (*a*) the secretary, who in this case advises customers when necessary; (*b*) the despatch department, who advise the foundry manager direct when the delivery promised is not adhered to. The original copy is retained by the foundry office, which has the information charted so as to enable all concerned to see at a glance what castings are due from day to day. The chart referred to is of very simple construction, being a ruled tracing from which prints were obtained showing: *Production Order Number*, *Quantity Ordered*, *Pattern Number*, and the quantity promised shown in columns under the date due.

DELIVERY PROMISE SHEET.

To	Clients to be / not to be Advised.	Date	Date	Promised
Secretary Despatch Dept. Foundry Office				

S. O. No.	Clients' O/No.	Clients.	Quan.	Description.

Instructions—
(a) Secretary to advise clients if required.
(b) Despatch Dept. to return to Production Engineer if promise is not kept.
(c) Foundry Office to record promise on chart.

P.E. Signature.

Form "D."

By this means it will be found that, except for causes beyond control, such as castings rejected on inspection, complaints of non-delivery to time will be a rare occurrence. Moreover, the chart is of great assistance in determining delivery dates, as one can see at a glance what is ahead. When orders are overdue, a fresh date is decided on, and a large coloured pin inserted in the board, in the square on which the original date fell, so that the number of days overdue on any order can be determined.

Progress.

The system of progressing is instituted solely to benefit the moulding and coremaking departments, as overcasts are often frequent. This is performed by the use of a board hung in the shops showing: (*a*) Orders available, *i.e.*, those for which the foundry office had received an advice from the pattern stores; (*b*) numbers cast in each heat showing the dates and heat numbers; (*c*) accumulative total cast. These records are made by the foundry office immediately after each heat. Such a system could, of course, be extended to cater for all operations, but its real value should naturally be considered in conjunction with the cost. In the present instance the value is in stopping overcasts, and the slight clerical cost was undoubtedly justified.

Replacements.

As mentioned, supplementary orders are issued for the replacement of shop scrap, quantities being recorded on the back of the foundry office copy from which these orders were issued.

In the case of returns by customers, special forms are used, on which are recorded particulars of such returns. These accompany the castings to the inspection department and the decision of the inspector added thereto. On completion of inspection, the form is sent to the order department, who, from the particulars outlined, issue a separate Sales and Production Order set, thereby treating such replacements as new orders and enabling the cost department to collect data as to the cost of such work.

From the foregoing it will be seen that the following information is easily obtainable: (1) Daily value and tonnage of orders received; (2) daily value and tonnage of orders despatched; (3) orders held up for the making of patterns; (4) orders held up, but for which patterns were in existence; (5) orders available for work; (6) orders completed under trade groups; (7) orders issued to replace shop scrap, so that costs are obtainable of replacements; (8) visible record of orders promised and overdue; (9) visible record of numbers cast off each pattern; (10) visible records of work available, but not in production.

In addition to the above, a check can be made of all despatches and invoices whether for goods actually delivered or charges incurred in pattern-making.

The duties and responsibilities of a foundry manager are so numerous, entailing so much attention to the technique of the trade, that his clerical work is often neglected or performed by an assistant with very little, if any, real knowledge of administration. Consequently, the records, which may be vital to the manager when making quick decisions, are useless to him. Hence, in many cases, such decisions are made from practical experience instead of actual facts.

Societe Normandy de Metallurgie.

It appears from further reports that although a liquidator has been appointed the liquidation of this company is more in the nature of a voluntary than a compulsory one, to enable a reduction of capital to be effected. No change will take place in respect of the personnel or continuity of the works, which are continuing to operate.

The company unfortunately suffers from having been constructed between 1917 and 1920, when costs were very high, and having started to make steel just as the trade depression was gathering force, and, further, the company has not the advantage of reserves accumulated through high profits during the war period, and under these circumstances a scaling down of the capital is necessary. It is necessary to distinguish between the Société Normande and the firm of Messrs. Schneiders, to whom it is affiliated, who have helped the concern very materially in the past; but of course this is only one of their many subsidiaries, all of which cannot be carried indefinitely in a period of unexampled depression.

Mr. Mark Firth, son of the chairman of Thomas Firth & Sons, Limited, who is about to be married, has been the recipient of a presentation from the managers, staff and foremen of the company as a token of their esteem and goodwill. Mr. H. Newbould made the presentation.

A Study of Carburisation in the Manufacture of Synthetic Cast-Iron.*

By Clyde E. Williams and C. E. Sims.

(*Continued from page* 62.)

The temperature of the bath of metal was taken at intervals throughout each run. A Leeds-Northrup optical pyrometer was used, two readings being taken by sighting first upon freshly-exposed metal and next upon the carburiser. These two readings compared very closely. The temperature was maintained fairly constant throughout all of the runs. It ranged between 1,350 and 1,450 deg. C., and was seldom higher or lower. Integrated temperatures for the various runs were not usually more than 50 deg. apart.

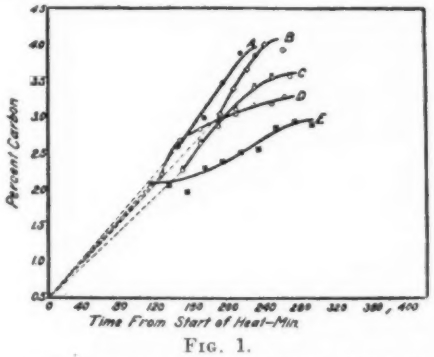


FIG. 1.

Showing the rate of carbon absorption when using different forms of carbon. Silicon content about 2 per cent. in each case; other impurities low. A=Coal-tar coke. B=Graphite. C=Low-ash coke, containing 13 per cent. ash. D=Charcoal. E=High ash coke, containing 25 per cent. ash.

The experiments performed in the 50-lb. furnace were repeated in the 300-lb. furnace. In all, seventy-eight individual melts were made. Conclusions have been drawn from the results obtained in all of these tests. All the data cannot be reproduced here, and, therefore, only results of the typical runs will be shown.

The curves in Fig. 1 show the rates at which different forms of carbon are absorbed in molten iron and the relative values of these varieties of carbon as carburisers. The dotted portion of any curve is indefinite and covers the melting period.

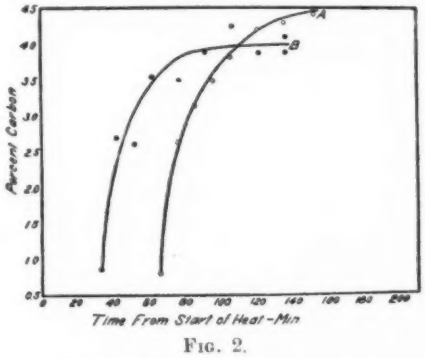


FIG. 2.

A=Using graphite as carburiser. B=Using charcoal as carburiser.
Showing the rate of carbon absorption at the lower concentrations of carbon. Tests made in small furnace on iron containing 2 per cent. Si.

The carburisation between 0.5 and 2.5 per cent. carbon has been largely ignored in this investigation for the reason that, throughout this range, absorption is so rapid that no appreciable difference in the various materials could be found. This is illustrated in Fig. 2. In these runs the metal was melted in the absence of carbon and then graphite and charcoal, respectively, were introduced. In each case the carbon in the iron increased from 0.8 per cent. to 2.7 per cent. within 10 minutes. Keller states that the carburisation of molten iron is very slow as compared with that of small solid particles of iron such as turnings. The tests just described and other similar ones show that the rate of solution of carbon in molten iron is rapid, but naturally diminishes as the saturation point is approached. Furthermore, observations seem to indicate that carburisation during the melting-down period is accomplished, not in the solid iron phase as intimated by Keller, but in the liquid iron as it gradually forms and mixes with the carbon which at first is present in large excess. Results in the experiments here described have shown that there is little difference in the amount of carbon introduced whether melting small steel turnings or comparatively large boiler-plate clippings. The extreme slowness of the penetration of carbon in the cementation process is well known. It is, therefore, very probable that in making synthetic cast iron most of the carburisation takes place after the steel has melted.

Comparison of the Different Varieties of Carbon.

Graphite.—Acheson granular resistor graphite was used in the tests. Graphite always gave a rapid rate and a high degree of carburisation, in practically every case excelling all the other forms of carbon. The superiority of graphite over granular resistor carbon or coal-tar coke, which is similar to petroleum coke, was not very great. Curve B, Fig. 1, shows the carburisation curve for graphite. The steep pitch of the curve and the high percentage of carbon obtained are particularly noticeable. The high apparent density of graphite undoubtedly assists it in obtaining good contact with the metal; its low ash content also unquestionably improves its carburising power as will later be brought out more fully.

Charcoal.—Curve D, Fig. 1, shows the rate of carburisation using charcoal in the large furnace. Much lower absorption of carbon is shown here than in the charcoal curve in Fig. 2, which was obtained from a test in the small pit furnace. There was much better contact between the charcoal and the metal in the small furnace than in the large one. All the tests have shown that good carburisation is possible only when good contact between the charcoal and the metal is obtained. Because of the light, porous nature of charcoal there is much difficulty in keeping it in good contact with the molten iron, especially near the arc or in the presence of a slag. The layer of charcoal on the bath should not be so thick as to prevent the arc from penetrating to the metal. In some types of furnaces, notably the pit-type furnace working continuously, charcoal should give satisfactory results.

Coal-tar Coke and Granular Resistor Carbon.—The coal-tar coke, made by the distillation of coal tar, was obtained from a local creosoting plant, and contains from 7 to 8 per cent. volatile matter and less than 4 per cent. ash. It is similar to petroleum coke and any reference made to it should apply with equal weight to petroleum coke. Curve A, Fig. 1, shows that coal-tar coke gives excellent carburisation, more nearly approaching graphite than anything else that has been used. Fig. 3 shows a comparison of coal-tar coke with some other cokes. Granular resistor carbon containing 5 per cent. ash has given results similar to those obtained with the coal-tar coke.

High-ash Coke.—During the early experiments a high-ash coke was used for carburising with consistently poor results, the maximum carbon content obtained in the iron being a little over 3 per cent. This coke was so noticeably inferior that an investigation of the reason was undertaken. Analysis showed that the coke contained 25 per cent. ash, and it was suspected that the trouble was due to this high ash content. Further experiments unquestionably proved that the high ash was the cause of the inferiority of the coke. A coke containing 13 per cent. ash gave much better carburisation than did the 25 per cent. ash coke.

*A Paper read before the American Electro-chemical Society.

but poorer carburisation than did the lower ash coal-tar coke. Fig. 3 shows the relative rates and degrees of carburisation obtained with these cokes. Results obtained in the small and in the large furnace are shown. These curves illustrate the detrimental effect of ash, and show that the absorption of carbon decreases as the ash content of the carburiser increases. The ash being a component part of the structure of the coke probably acts as a protective coating on the carbon, serving to keep it from intimate contact with the metal. this effect being intensified as the carbon dissolves and the relative amount of ash becomes larger. Graphite resistor carbon, coal-tar coke, petroleum coke, and charcoal should be desirable carburisers because of their low ash content. Of these, the denser varieties should be preferred.

Silicon Carbide.—Experiments with carborundum firesand (an impure silicon carbide) proved it to be an efficient means of introducing both silicon and carbon into iron. Inasmuch as the proportion of silicon to carbon in silicon carbide is roughly 2 to 1, it cannot be used for introducing all of the required carbon because too much silicon would result. It would also be too expensive for this purpose. However, its cost for introducing silicon would almost equal that of ferro-silicon and it would have the added advantage of effecting some carburisation. Fig. 4 shows the result of a test in which a high-ash coke and silicon carbide were used in conjunction. The scrap-steel plate was melted with a cover of the coke and held molten for an hour. Previous experience had shown that after an hour there would be practically no further absorption of carbon from this coke. At

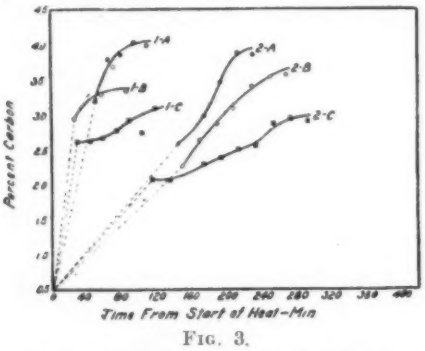


FIG. 3.

Showing the effect of ash content of carburisers on the rates of carbon absorption. Curves No. 1 from tests in 50 lb. pit furnace. Curves No. 2 from tests in 300 lb. roofed furnace.
A=Coal-tar coke (ash content, under 4 per cent.).
B=Low-ash coke (ash content, 12 per cent.).
C=High-ash coke (ash content, 25 per cent.).

this point, indicated by the arrow on the curve, carborundum firesand was thrown on the melt, with the result that the absorption of carbon continued rapidly until 3.9 per cent. carbon had been reached. Carbon and silicon were taken up by the iron in the ratio of 0.8 carbon to 1.55 silicon, which is very close to the proportion of carbon to silicon in silicon carbide. Assuming that the carborundum firesand contains 75 per cent. silicon carbide, the recovery in the iron of this silicon carbide as silicon and carbon was 75 per cent.

In most cases it will be noticed that the last point in the curve is slightly lower than the preceding point. The last point is taken from the analysis of the pig sample, and the other points are taken from the analysis of the samples obtained in the graphite mould. Due to the slow rate of cooling of the pigs, those which contained large amounts of silicon or carbon ejected graphite as "kish" and hence contained less carbon than their equivalent samples which were cast in small moulds, and therefore cooled too rapidly to permit the formation of so much graphite. The difference ordinarily amounts to about 0.1 per cent. carbon.

Effect of Slags.

In general all of the tests have shown that slags interfere with carburisation. This interference is due to the physical effect of the slag in preventing contact between the carburising material and the metal. Therefore, in the tests unless the effect of the slag was being particularly considered, the surface of the metal was kept as free from slag as possible. The effect of high-ash coke has already been discussed (see Fig. 3). The ash from this coke consists essentially of alumina and silica. Curve F, Fig. 5, shows the effect of a high silica-alumina slag upon carburisation with low-ash coke (coal-tar coke). This slag was accidentally introduced by the fusing of part of the furnace lining. Results of other tests have indicated the retarding effect of siliceous slags upon carburisation.

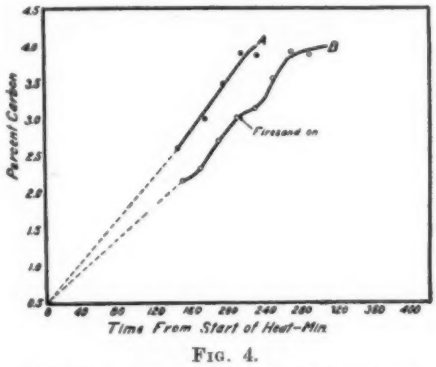


FIG. 4.

Showing the relative rates of carbon absorption when using coal-tar residue and carborundum firesand.
A=Coal-tar as carburiser. B=High-ash coke in first stage; firesand introduced as noted.

High lime-slags have practically the same effect due to the physical action tending to prevent contact. However, if conditions are right for the formation of calcium carbide, lime may aid carburisation. Curve B, Fig. 5, shows the results of tests with low-ash coke and a lime slag. Calcium carbide was formed by the arc, thus causing rapid introduction of carbon into the iron. In another test using calcium carbide and carbon, carburisation was still more rapid. Curve C is taken from an experiment in which calcium carbide alone was used as the carburiser. The carbon content of the iron increased rapidly and then stopped. Only 50 per cent. efficiency of the carbon in the carbide was obtained, showing that either a large excess of carbide must be used, or that carbon must be charged along with the calcium carbide. Curves E and H, Fig. 5, show the effect of lime on a high-ash coke. Carburisation proceeded fairly rapidly at first, but practically stopped until the first slag, which had by now largely increased in silica and alumina from the ash, was replaced by a fresh lime-slag.

Effect of Impurities.

In studying the effects of the common impurities in cast iron, it has been found that innumerable combinations and concentrations from them are possible. In these experiments the effect of silicon

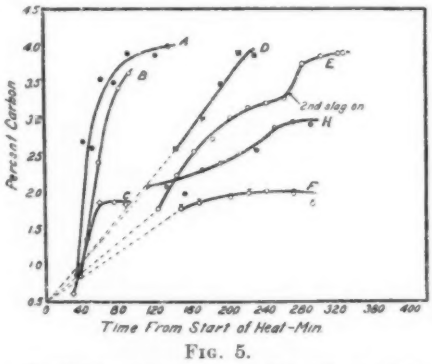


FIG. 5.

Showing the rates of carburisation with and without slag.
The curves denote.—Run in small furnace, using: A, charcoal alone; B, coke and a lime-fluorspar slag; C, calcium carbide and a fluorspar slag. Run in large furnace, using: D, coal-tar coke alone; E, high-ash coke and a lime-fluorspar slag; F, coke and silica-alumina slag; H, high-ash coke alone.

in the absence of other added impurities was first studied. Then the effects of sulphur, phosphorus, and manganese in the presence of about 2.0 per cent. silicon were investigated. Enough of the impurity was introduced to indicate its effect, but not enough to get too far away from concentra-

tions that might be met in practice, although in a few instances an unusually large amount was used in order to intensify the effect.

Silicon.—Although there is reason to suspect that silicon decreases the content of combined carbon in iron, in these tests it was repeatedly found to have practically no effect. The rates of carburisation were about the same for steel containing 0.2, 2.0,

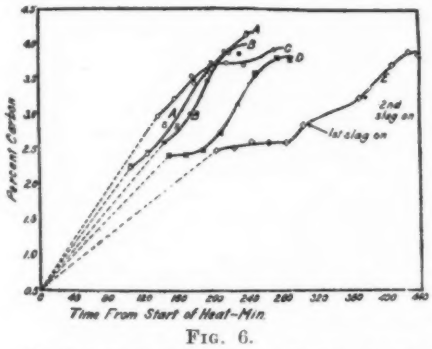


FIG. 6.

Showing effects of impurities on the rate of carbon absorption. Two per cent. silicon in all except curve C. Manganese, phosphorus and sulphur are low except as indicated below.

Percentages for the curves are as follows: A, 1.75 manganese; B, 2.00 silicon (other impurities low); C, 0.2 Si, 0.4 Mn, 0.5 S. & P.; D, 0.7 phosphorus; E. 0.75 sulphur.

and 7 per cent. silicon. Curves B and C in Fig. 6 show the rates of carburisation of steel containing 2.0 and 0.2 per cent. silicon respectively. The curve for 7 per cent. silicon is not shown here, but its slope is very much the same as the slopes of curves B and C. Thus it is seen that in these tests the content of silicon had no effect upon the rate of absorption of carbon by molten iron.

The curve in Fig. 7 shows the relation between the carbon and silicon contained in the metal obtained in the three runs made for the purpose of comparing the effect of silicon. The points on the curve represent the analyses of samples that were taken a few minutes before the charge was tapped. The samples were chilled so quickly that no graphite was ejected during cooling. These values, therefore, represent the carbon contained in the liquid iron and not in the cold pig. The curve was drawn to pass above the point corresponding to 7 per cent. silicon, because complete saturation of the iron had not taken place when the sample was taken. There is practically no difference between the carbon content of the chilled samples and that of the slowly cooled pig samples in the results for the 0.2 and 2.0 per cent. silicon runs, but there is a difference of 0.46 per cent. in the case of the 7 per cent. silicon run. These

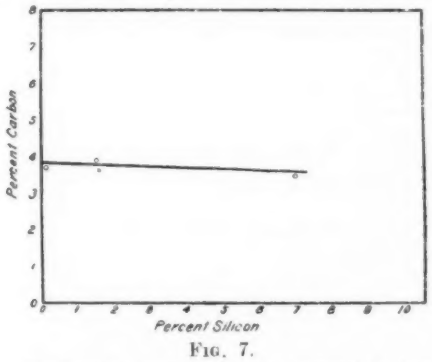


FIG. 7.

Showing the amount of carbon dissolved by iron containing various amounts of silicon, other conditions being similar. Points do not indicate saturation values.

observations show that although the presence of a large quantity of silicon does decrease the amount of carbon in the pig, it does not affect the amount of carbon that is absorbed by molten iron.

Manganese.—Curves A and C in Fig. 6 show the rates of carburisation for high manganese and low manganese irons respectively. By low manganese is meant 0.40 per cent., and by high manganese, 1.75 per cent. Curve A has a steeper slope than Curve B, indicating that manganese is beneficial. These curves are plotted from results obtained in the small furnace, but not indicated in this discussion. Although the results show a distinct effect, it may not be large enough to warrant the statement that manganese is beneficial. However, it is to be expected that manganese aids the carburisation of iron. Experiments are now being conducted to bring out further data upon this point.

Sulphur.—It is not to be expected that sulphur would materially affect the absorption of carbon by iron. However, during this investigation, the effect of sulphur has been strikingly noticeable. Sulphur has always appeared to retard the rate of carburisation and decrease the total absorption of carbon. Curve E in Fig. 6 and the curves in Fig. 8 are plotted from results obtained in a test in the large furnace, in which 0.8 per cent. sulphur was introduced during the melting period. Fig. 8 shows that the absorption of carbon had practically ceased when the first desulphurising slag was added, after which it increased regularly as desulphurisation continued. The effect of sulphur on the rate of carburisation is shown in Fig. 6. From an examination of the results obtained in several other tests, not described here, the deleterious effect of sulphur is evidenced when the sulphur content is as low as 0.1 to 0.2 per cent., although the effect is not so marked as in the example discussed above.

It is surprising that sulphur should have such a marked effect, and it is not improbable that further work may show that something other than sulphur is responsible. However, the results of

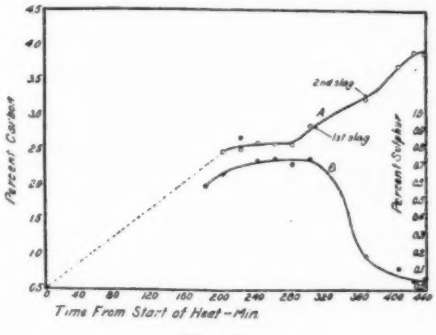


FIG. 8.

Showing the relation between carbon absorption and sulphur content. Sulphur was eliminated and carbon introduced toward the end of the heat by two successive carbon-lime-fluorspar slags.
A=Carbon curve. B=Sulphur curve

the present study show very plainly that in the tests here described sulphur retards the carburisation of molten iron.

Phosphorus.—The study of the effect of phosphorus shows that it probably does not influence carburisation. Curve D, Fig. 6, showing the results of the high phosphorus (0.75 per cent. P) run, has an average slope of approximately the same degree as have the curves for the phosphorus-free runs. The slow rate of carburisation at the beginning of this test was undoubtedly due to the presence of some slag, because when this slag was removed absorption of carbon took place rapidly. In other tests performed in the small furnace, phosphorus showed practically no effect upon the rate of carburisation.

Conclusions.

1. The results indicate that the carburising ability of different forms of carbon decreases as the ash content increases, and that the denser varieties of carbon are more effective than the more porous ones. Artificial graphite, resistor carbon, petroleum coke, and coal-tar coke give better results than the higher ash cokes or charcoal. Although the low ash content of charcoal would put it in the class with graphite, its porous nature prevents good contact with the metal. Graphite, because of its lower ash and higher density, has given slightly better results than any of the other forms of carbon used.

2. The presence of slag decreases the rate of carburisation by tending to prevent contact between the metal and the carburiser. This action is more pronounced as the acidity of the slag increases.

Lime-slags counteract the deleterious effect of the high ash in coke, and, if conditions are right for the formation of calcium carbide, aid carburisation.

3. Silicon carbide is an excellent medium for adding both silicon and carbon to iron. It cannot be used for introducing all the carbon because too much silicon would be carried into the metal and also the cost would be too high. Silicon carbide should be used in the comparatively inexpensive form of firesand and in conjunction with one of the low-priced carburisers, such as coke.

4. Silicon has no effect upon the rate or the degree of carburisation, although it may slightly decrease the content of total carbon in the resultant pig.

5. Manganese seems to increase both the rate and the degree of carburisation, although this increase is so small as to be negligible for the amounts of manganese ordinarily met with in commercial iron.

6. Phosphorus has no effect upon the rate or the degree of carburisation, although, like silicon, if present in large quantities, it may decrease the content of the total carbon in the pig.

7. Sulphur probably decreases the rate and the degree of carburisation. No attempt has been made to explain this unexpected action.

8. An increase in temperature from 1,350 to 1,450 deg. C. has no noticeable effect upon the carburisation.

Acknowledgments.

Much credit is due Mr. B. M. Larsen, "fellow" in electrometallurgy, University of Washington, and Mr. A. E. Anderson, junior metallurgical chemist, U.S. Bureau of Mines, for assistance with the experimental and analytical work. Grateful acknowledgment is made to the College of Mines of the University of Washington for the use of its laboratory facilities, and to members of its faculty for helpful co-operation. The authors also wish to express their appreciation for the helpful encouragement and criticism received from Messrs. D. A. Lyon and O. C. Ralston of the U.S. Bureau of Mines.

Obviating Contraction Strains.

By F. C. Edwards.

If it is true that engineering design consists of one part calculation and five parts judgment, we may quite safely assert, *a fortiori*, that in the equation of good casting design, judgment and calculation may be represented respectively as ten to one. That this is by no means an unfair balance of values will, perhaps, be readily conceded when it is remembered that the convenient and much-abused "factor of safety"—generally dependable in the case, say, of mild-steel structures—if applied solely on the basis of more metal, more strength, may produce, in castings, diametrically opposite results to those intended.

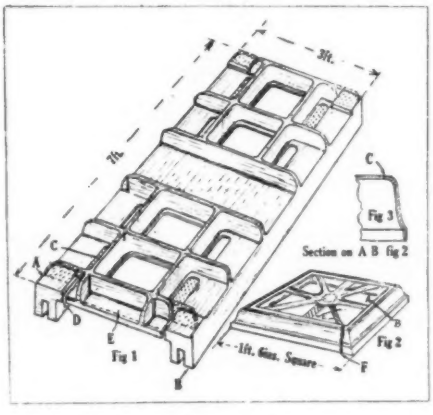
In this sphere, by the way, the wielder of mathematical formulæ is no match for the practical foundryman. The latter's judgment is almost invariably vindicated. It is, nevertheless, frequently undervalued. With regard to contraction strains, in particular, foundry opinion is of infinite value to the designer. It should never be slighted—as is, unfortunately, sometimes the case. It deserves, indeed, to be assiduously courted.

Readers of this journal will probably call to mind cases where patterns have been sent to the foundry, perfect, perhaps, in the eye of the designer, but in which—almost at a glance—fatal sources of weakness have been detected by the foundry chief. By a kind of intuitive perception—the fruit, so to speak, of daily observation and experience—he unerringly indicates, say, the probable line of fracture, and suggests an effective remedy. This, of course, may involve sacrifice in design or expense in subsequent machining. On such a point, however, there is really no room for argument. Though one's pet design be somewhat mutilated, or machining cost be slightly increased, these are obviously lesser evils to face than the probability of a scrap casting, or the likelihood of contraction strains being present in an apparently sound casting. Occasionally, of course, the risk is taken. If the casting flies in cooling, the foundry judgment is vindicated; and it is not necessarily disproved if the casting remains intact.

A striking example of the former case is illustrated in Fig. 1. As will be gathered from the sketch, the pattern was well ribbed, and it was considered to be generally sound in design. On its arrival in the foundry, however, its weak spots were soon detected. On account of the presence of machined facings, A, at the extreme corners, the end transverse ribs were not carried right across, as in the case of the other ribs. To the trained eye it was evident that this shortening of the ribs, taken in conjunction with the comparatively heavy longitudinal bars, B, and the lightening holes, C, constituted a real source of weakness. For various reasons, however, it was decided to make no change in the design.

Exactly as predicted, and in spite of the fact that the side bars were quickly exposed, after casting, to assist equalisation of cooling, the casting gave way at D, but at one end only.

The foundry manager's advice was then acted upon. Holes, C, were filled up, and the ends, E, were made ¼in. thicker. In addition, the ribs were



continued to the outside, as shown in dotted section, to be afterwards machined off. The result was perfectly satisfactory; and no further trouble was experienced with subsequent castings.

Figure 2 is another illustration of the effect of, and remedy for, contracting strains. As is shown in Fig. 3, the metal is only ¼in. in thickness, and there is an internal lip, C, round the top edge. The gates, at their junction with the castings, must be almost knife-edged to avoid breaking pieces out of the frame when they are knocked out. Hence the large number of gates employed—more, perhaps, than some moulders would consider necessary. In addition, of course, they serve as an insurance against the possibility of "cold" metal.

Almost immediately after casting, the two sectioned gates, E, are broken out. This is done to relieve the contraction strain. If this precaution is neglected, the frame invariably flies across one of the corners, as at F.

Enough has been said, perhaps, to show that contraction strains—baneful though they be—can be obviated, but practical experience alone can best furnish the solution.

The Basset Process.—The report of the Société des Aciéries Basset states that while the chemistry of their steel-making process had entirely fulfilled the claims of the inventor, questions as to the form of the furnaces and their linings had presented great difficulties, mainly on account of the exceptionally high temperature prevailing in the furnace. This temperature made possible the obtaining of a product free from injurious impurities, and although it was technically possible to reduce it, the firm did not desire to discard the advantages which it afforded, and consequently attention had been concentrated on the improvement of the refractory properties of the lining. Efforts in this direction had met with a measure of success, and the progress achieved gave the firm confidence that a satisfactory result would shortly be reached. During 1921 the Company had studied the most rational form of furnace corresponding to the various qualities of pig-iron used and steel obtained. Although actual commercial activity had not yet commenced, initial deliveries of metal had been made.

The Development and Manufacture of High-Tenacity Brass and Bronze.*

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from page 80.*)

Tin Brass.

The chief function of tin in brass is to improve the corrosion-resisting properties. In complex brasses of high ductility 0.7 per cent. is the maximum amount that should be used. In naval brass the limit is 1 per cent.

In a series of exploratory casts it was found that the amount of tin that brass will take into solution in the solid state is determined by the Zn. content. In the "alpha" series, the lower the Zn. content the greater the quantity of Sn. which it can dissolve, *e.g.*, an 80/20 brass will dissolve 5.0 per cent., whilst a 70/30 will scarcely dissolve 1.0 per cent. Of the "alpha-beta" series, the standard 59/41 brass dissolves approximately 1.0 per cent. when sand-cast and 1.2 per cent. chill cast, whilst as the Zn. content increases up to 47 per cent. the solubility rises to a maximum of 1.80 per cent. From these results 0.5, 1.0, 2.0 and 3.0 per cent. tin brasses were made of a 59 per cent. copper base. Conditions of manufacture were those outlined for the aluminium brasses, introducing the Zn. and the Sn. as such, last.

Physical Test Results.—These are detailed in Table IV.

Structure.—There is little perceptible difference in the structure of an "alpha-beta" brass containing 0.5 per cent. Sn. and that containing 1 per cent. Exceeding 1 per cent. a brittle Cu.-Sn. compound, resembling the Cu.-Sn. compound, found in ordinary Sn. bronzes, makes its appearance. The effect of this constituent is shown to be similar to the "gamma" compound in ordinary brass.

From these results one cannot regard Sn. in the same light as any of the elements previously considered, it being neither a Cu.- nor a Zn.-replacing element; although, structurally, attempts have been made to consider it as a Zn.-replacing element, giving to it a co-efficient of equivalence of 2.

Iron Brass.

Copper and iron form a heterogeneous series of alloys except at the terminals of the curves. Between these proportions the alloys consist of two constituents, the one rich in iron the other rich in copper. Carbon and copper do not associate in any form, and the presence of C. in Fe. reduces the solubility to any extent that neither steel nor cast iron can be satisfactorily alloyed with copper, but merely exist side by side as a mechanical mixture of one with the other. Zinc readily unites with iron.

TABLE IV.—*Showing the Effect of Tin on the Physical Properties of Brass.*

Series No.	Composition. Cu.	Zn.	Sn.	Fe.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. per cent. on 2 in.	R. A per cent.
S.1	59.95	39.38	0.47	0.20	As cast	11.0	26.2	44.0	42.0
					As forged	15.6	28.8	38.0	60.0
S.2	58.90	40.10	1.00	Trace.	As cast	9.6	26.7	32.0	33.5
					As forged	13.6	28.6	38.0	44.6
S.3	58.82	38.76	2.11	0.31	As cast	11.8	26.1	13.0	15.0
S.4	59.17	37.63	2.98	0.22	As cast	16.4	21.25	1.5	3.2

TABLE IV.—continued.

Series No.	Tensile Fracture.	Alternating impact No	Fracture.	Brinell hardness No.	Sclerescope hardness No.
S.1	Fine, stony, silky edges. More or less hackly ..	77	Fine, silky, semi-vitreous	87	13
	Fine, granular, silky edges. Cup and cone ..	113	Fine, granular, semi-vitreous in upper half.	107	15
S.2	Fine, stony, silky edges. Trace of crystallinity existing as exhibited by S.3.	47	Fine, crystalline, with a slight appearance of the laminated crystals exhibited by S.3.	98	15
	Fine, granular, silky edges. Semi-cup and cone ..	107	Fine, granular, semi-vitreous in upper half.	107	16
S.3	Short, coarsely crystalline, consisting of greyish and stony crystals existing alternately	5	Short, grossly coarse laminated crystals.	114	20
S.4	Coarse, alternating grey and stony coloured crystals.	1	Short, coarse, laminated crystals ..	136	23

As Cast.—0.50 per cent. Sn. increases the yield point and maximum stress 2.25 tons and 1.3 tons respectively without affecting the elongation, reduction of area, and alternating impact strength. Increasing to 1.0 per cent. hardens, without strengthening, and impairs both the ductility and impact strength. This embrittlement is naturally accentuated by further quantities of Sn., as in alloys S3 and S4, the latter having little strength and being void of ductility.

Forging.—No difficulties were encountered in the forging of alloys S1 and S2, and worked with the ease of ordinary Muntz metal. The test results of alloys S3 and S4 in the "cast" condition were such that they did not justify consideration in the forged or heat treated condition.

After forging the yield point of S1 is raised 6.6 tons per sq. in., and the maximum stress 2.8 tons per sq. in., but the elongation is slightly reduced. The drop in ductility, however, is not of material importance, the alternating impact figure being raised no less than 15 per cent. Whilst the physical properties of the 1 per cent. Sn.-brass in the "cast" state are inferior to those of 59/41, they are superior after forging, but it is clearly demonstrated that 1 per cent. is the limit of practical utility.

Iron may be introduced into brass by means of a Cu.-Fe. or Zn.-Fe. stock alloy. The preparation of either stock alloys is a comparatively simple operation, if certain elementary chemical laws are observed and manufacture carefully conducted. The first essential in the preparation of a Cu.-Fe. stock alloy is the use of pure iron, not steel, cast iron or ferro-manganese. The iron may be purchased in sheet form as scrap clippings from horse-shoe nails or as Swedish bar-iron. The Cu. should be melted to a good temperature under a suitable slag, and the iron introduced in small quantities at a time up to about 10 per cent. and well stirred. When thoroughly alloyed, the pot should be withdrawn from the furnace, again stirred and quickly poured out into a thin flat mould. Unless this latter precaution is taken, there is a danger of the iron rich material formed segregating in the upper regions of the cast.

Correctly made, a 10 per cent. Fe., Cu.-Fe. stock-alloy is soft, and has a Brinell hardness of 62 against 55 for pure copper and 92 for pure iron.

Johnson recommends the use of a Zn.-Fe. stock-alloy, prepared by immersing strips of clean sheet-iron in a crucible of molten Zn., the temperature of which is maintained for several hours at 800 deg. C., in a muffle furnace. Luting on the

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

crucible lid is suggested for preventing volatilisation.

This method is costly on account of the difficulties of manufacture; moreover, one cannot dissolve, commercially, more than 6 per cent. Fe.; consequently its use cannot be adopted for high-Fe. iron brass of low-Zn. content. Commercial Zn.-Fe. stock-alloys are generally prepared by liquidating the hard Zn. from galvanising works to remove part of the Zn., and then heating the Fe.-rich residue to a high temperature until the desired Fe. content is obtained. The objection to this by-product is its irregular composition and the impurities it carries.

Effect of Iron on 70/30 Brass.

To ascertain the effect of iron on 70/30 brass ("alpha") three alloys were made and designated F, F1, and F2. The first contained 70 per cent. Cu. and 30 per cent. Zn.; the second 69.75 per cent. Cu., 29.75 per cent. Zn. and 0.5 per cent. Fe.; and the last 69.50 per cent. Cu., 29.50 per cent. Zn. and 1 per cent. iron.

The iron was introduced by the 10 per cent. Fe., Cu.-Fe. stock-alloy. No peculiarities or difficulties were encountered either in melting or pouring. The tensile, impact and hardness tests are tabulated in Table V.

In the cast condition 1 per cent. Fe. is shown to raise the yield point from 6.5 to 10.7 tons per sq. in., the tenacity from 16.7 to 24.5 tons sq. in., and the Brinell hardness from 55 to 76 without materially affecting the ductility as measured by both the static and dynamic stress tests. After cold-rolling and annealing, the yield point is raised from 8 to 11 tons per sq. in. and the tenacity from 21.5 to 26.5 tons per sq. in., also without affecting the ductility. The most interesting feature is the beneficial effect of iron on the physical properties in the cast state, whilst the range of physical properties possible from 70/30 brass containing 1 per cent. Fe. is noteworthy, as they give a yield point of 10.7 to 18.5 tons per sq. in., a maximum stress of 24.5 to 41 tons per sq. in., an elongation of 14 to 54 per cent., a reduction of area of 44 to 67 per cent., and a Brinell hardness of 76 to 185.

A series of experiments on the effects of Fe. on malleability—which property was determined by cold-rolling to destruction, cupping and drawing tests—proved that Fe. up to 1 per cent. is not detrimental if correctly alloyed, the intervening annealings correctly performed and the changed physical properties taken to account. Fuller details of these tests are published in the "Metal Industry," Vol. 17, No. 22, page 424.

TABLE V.—*Showing the Effect of Iron on the Physical Properties of 70/30 Brass.*

Mk.	Composition. Cu.	Zn.	Fe.	Treatment.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Alternating impact No.	Izod impact No.	Brinell hardness No.	Scleroscope hardness. No.
F.	69.80	30.20	Trace.	As cast	6.50	16.70	58.00	46.20	79	41	55	15
				Cold rolled and annealed, 650° C. ..	8.00	21.50	68.00	65.00	—	61	57	15
F.1	69.67	29.82	0.50	As cast	8.70	19.40	58.00	47.20	61	49	64	12
				Cold rolled and annealed, 775° C. ..	9.50	22.80	65.00	67.00	—	—	54	10
F.2	69.42	29.57	1.00	As cast	10.70	24.50	50.00	59.30	80	45	76	12
				Cold rolled and annealed, 700° C. ..	14.00	27.00	47.00	62.00	—	63	92	12
				Cold rolled and annealed, 825° C. ..	11.00	26.50	54.00	67.00	—	—	76	12

Effect of Iron on 59/41 Brass ("Alpha Beta.")

The composition of the materials used were similar to those adopted for the 70/30 series, except that the iron was introduced into alloy 1.F.2. by means of a Zn.-Fe. stock-alloy and that $2\frac{1}{2}$-in. sq. ingots were cast instead of 1-in. slabs. The tests results are shown in Table VI.

In ingot form 1.0 per cent. Fe. improves both the tenacity and shock-resisting properties. No further improvement is to be gained by exceeding this quantity whilst the shock-resisting properties tend to fall; particularly is this so in the case of alloy 1.F.2. The low ductility of this alloy, however, is accounted for to some extent by the crystalline form of the impurities introduced by the Zn.-Fe. alloy, and is typical of the troubles encountered when this impure material is used for the purpose of introducing iron.

Hot-working results in an all-round improvement of the tenacity of each alloy, having little influence on the ductility, except in the case of alloy 1.F.2, which improvement is as expected.

Microstructure. — The Fe.-rich constituent appears to be similar in form to that found in the 70/30 brasses, although the limit of solubility seems to be increased. It exerts a similar action on the crystal growth.

Effect of Iron on 53.3/46.7 Brass ("Beta.")

In view of the fact that the hardness of pure iron is similar to that of 59/41 brass, its limitations as a hardener or strengthener will be in brasses containing up to 41 per cent. Zn., and that it will neither effect the tenacity nor hardness of "beta" brasses. Its common use in high

Microstructure.—The beneficial influence of Fe. in the manufacture of brass castings is readily explained by means of the microscope.

The outstanding feature is the refining effect of small quantities of iron on the texture and the improved homogeneity. The explanation of the mechanism of its action is not far to seek. Iron exists in brass as an insoluble constituent rich in Fe. in the form of finely-divided particles, each of which acts or tends to act as a nucleus for the germination of a primary crystal-grain. The true solubility of Fe. in 70/30 brass is unknown. By ordinary microscopical examination the Fe.-rich particles are just discernible between 0.35 and 0.45 per cent. That the actual solubility is less than this figure is shown by the grain-refining of less quantities than 0.35 per cent. For ordinary workshop practice, however, 0.35 per cent. may be taken as the solubility limit, this being the safe-working limit of iron for articles which are to be spun, cupped or drawn.

TABLE VI.—*Showing the Effect of Iron on Alpha-Beta Brass.*

Series No.	Composition. Cu.	Zn.	Fe.	Pb.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Fracture.	Alternating impact No.	Fracture.	Brinell hardness No.	Sclerescope hardness No.
1.F.	58.96	41.04	—	—	As cast ..	8.80	24.90	45.00	49.70	Fine, stony, semi-cup and cone.	79	Fine, granular, silky edges.	90	14
					As forged ..	9.60	26.00	47.50	62.00	Fine, stony, silky edges.	87	Fine, granular, silky edges.	90	14
1.F1.	59.37	39.68	0.95	Nil.	As cast ..	9.40	26.80	44.00	44.60	Fine, silky, semi-cup and cone.	95	Fine, silky, semi-vitreous.	90	13
					As forged ..	13.90	28.80	44.00	63.70	Fine, granular, cup and cone, silky edges.	81	Fine, stony, semi-vitreous.	107	14
1.F.2	59.04	38.95	1.56	0.45	As cast ..	11.00	26.80	33.00	30.60	Fine, stony, granular, semi-cup and cone.	31	Fine, stony ..	85	13
					As forged ..	13.60	27.60	43.00	59.30	Fine, granular, cup and cone, silky edges.	49	Fine, stony, inclined to be vitreous.	98	15
1.F.3	59.12	38.36	2.52	Nil.	As cast ..	10.00	26.50	46.00	49.70	Fine, silky, semi-cup and cone.	71	Fine, slightly more silky in appearance than 1.F1.	92	14
					As forged ..	15.80	28.30	39.00	54.60	Stony, granular, uneven.	79	Fine, stony, semi-vitreous.	110	16

June 30th,

BLAST FURNACES OF THE

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Total number of Furnaces Built on June 30th, 1922
Total number of Furnaces in Blast on June 30th, 192
Increase or Decrease in the number of Furnaces Built
Increase in the number of Furnaces in Blast since Ma

Furnaces Blown-in since March 31st, 192

Scotland (4).—David Colville & Sons, 3; Carron Co., 1.
North Wales (1).—Darwen and Mostyn Iron Co., 1.
Lincolnshire (2).—Redbourn Hill Iron and Coal Co., 1; Trent Iron Co., 1.
hropshire (1).—Lilleshall Co., 1.
Cleveland (4).—Cochrane & Co., 1; Dorman, Long & Co., 1; Pease & Partners, 2.
South and West Yorksh
Lancashire (1).—Darwe
Northamptonshire (1).—
South Staffordshire and

Furnaces Blown-out since March 3

Durham and Northumberland (2).—Seaton Carew Iron Co., 1; Pease & Partners, 1.
Cleveland (2).—Wm Whitwell & Co., 2.
West Cumberland (2).—United Steel Companies, 2.
North Staffordshire (1).—
Lancashire (1).—Charc

Furnaces being built at presen

(See below).

Furnaces being Re-lined at pres

Durham (5).—Consett Iron Co., Ltd, 2; Linthorpe-Dinsdale Smelting Co., 2; Pease & Partners, 1.
Nottingham and Leicestershire (2).—Stanton Ironworks Co., 1; Bestwood Coal and Iron Co., 1.
Cleveland (18).—Bolckow, Vaughan & Co., Ltd., 9; Sir B. Samuelson & Co., Ltd., 2; Dorman, Long & Co., Redcar, 1; Skinningrove Iron Co., Ltd., 1; Cochrane & Co., 2; Pease & Partners, 2; North Eastern Steel Co., 1.
South Staffordshire (3).—M. & W. Grazebrook, 1; N. Hingley & Sons, 1; Alfred Hickman, 1.
Staffordshire, North (3).—Robert Heath & Low Moor, 2; Goldendale Iron Co., 1.
South and West Yorkshire (2).—Newton, Chambers & Co., 1; Robert Heath & Low Moor, 1.
Cumberland (3).—United Steel Companies (Workington), 2; (Distington), 1.
Shropshire (1).—Lilleshall Co., 1.
Derbyshire (5).—Sheepb Works Co., 3.
Northamptonshire (2).—
Lincolnshire (5).—North John Lysaght, 2
Lancashire (5).—North and Mostyn Iron
Scotland (4).—James D
South Wales (4).—Ebbw Ltd., 2; Blaena
North Wales (1).—Darw

Scotland.

Name of Firm.	Total in blast on June 30.	In blast June 30, making			Average in blast.		Total built.	Furnaces relining
		Hem.	F'gs. & F'dy.	Basic.	June qr.	Mch. qr.		
Langloan Iron and Chemical Co., Ltd., Coatbridge	—	—	—	—	—	—	5	—
Coltness Iron Co., Ltd., Coltness	—	—	—	—	—	—	9	—
Dixon, Wm., Ltd., Calder	—	—	—	—	—	—	7	—
Dixon, Wm., Ltd., Govan	—	—	—	—	—	—	6	2
Dunlop Iron & Co., Ltd.	—	—	—	—	—	—	5	1

Cleveland District.

Name of Firm.	Total in blast on June 30	In blast June 30, making			Average in blast.		Total built.	Furnaces relining
		Hem.	F'gs. & F'dy.	Basic.	June qr.	Mch. qr.		
North Eastern Steel Co., Ltd.	2	—	2	—	2	2	4	1
Gjers, Mills & Co., Ltd.	2	2	—	—	2	2	5	—
Cargo Fleet Iron Co., Ltd.	1	—	—	1	1	1	3	—
Tees Furnace Co., Ltd., Lackenby	—	—	—	—	—	1	3	—
Bolckow, Vaughan &								

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re (1).—Robert Heath & Low Moor, 1.
n and Mostyn Iron Co., 1.
-Lloyd's Ironstone Co., 1.
Worcestershire (1).—G. & R. Thomas, 1.

31st, 1922	8

-Goldendale Iron Co., 1.
al Iron Co., 1.

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ent time	63

ridge Coal and Iron Co., Ltd., 1; Clay Cross Co., 1; Stanton Iron
Kettering Iron and Coal Co., 1; Islip Iron Co., 1.
Lincolnshire Iron Co., Ltd., 1; Frodingham Iron and Steel Co., 2;
Lonsdale Iron and Steel Co., Ltd., 2; Charcoal Iron Co., 1; Darwen
o., 1; Wigan Coal and Iron Co., 1.
nlop & Co., 1; Wm. Dixon, 2; Shotts Iron Co., 1.
Vale Steel, Iron and Coal Co., Ltd., 1; Guest, Keen & Nettlefolds,
on Co., 1.
en and Mostyn Iron Co., 1.

Northamptonshire.

Name of Firm.	Total in blast on June 30.	In blast June 30, making. Hem.	Fgs. & F'd'y.	Basic.	Average in blast. June quarter	Mch. qr	Total built.	Furs relining
Cransley Iron Co...	—	—	—	—	—	—	nil	—
cutors of P. Phipps, unsbury Hill Iron orks	—	—	—	—	—	—	nil	—
ed Steel Companies.	—	—	—	—	—	—	4	—
d, Wellingboro' Iron Co., Ltd., ntrapston	2	—	2	—	2	2	4	1

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HEXAGONAL BRICKS
FOR HOT BLAST STOVES

Lime-slags counteract the deleterious effect of the high ash in coke, and, if conditions are right for the formation of calcium carbide, aid carburisation.

3. Silicon carbide is an excellent medium for adding both silicon and carbon to iron. It cannot be used for introducing all the carbon because too much silicon would be carried into the metal and also the cost would be too high. Silicon carbide should be used in the comparatively inexpensive form of firesand and in conjunction with one of the low-priced carburisers, such as coke.

4. Silicon has no effect upon the rate or the degree of carburisation, although it may slightly decrease the content of total carbon in the resultant pig.

5. Manganese seems to increase both the rate and the degree of carburisation, although this increase is so small as to be negligible for the amounts of manganese ordinarily met with in commercial iron.

6. Phosphorus has no effect upon the rate or the degree of carburisation, although, like silicon, if present in large quantities, it may decrease the content of the total carbon in the pig.

7. Sulphur probably decreases the rate and the degree of carburisation. No attempt has been made to explain this unexpected action.

8. An increase in temperature from 1,350 to 1,450 deg. C. has no noticeable effect upon the carburisation.

Acknowledgments.

Much credit is due Mr. B. M. Larsen, "fellow" in electrometallurgy, University of Washington, and Mr. A. E. Anderson, junior metallurgical chemist, U.S. Bureau of Mines, for assistance with the experimental and analytical work. Grateful acknowledgment is made to the College of Mines of the University of Washington for the use of its laboratory facilities, and to members of its faculty for helpful co-operation. The authors also wish to express their appreciation for the helpful encouragement and criticism received from Messrs. D. A. Lyon and O. C. Ralston of the U.S. Bureau of Mines.

Obviating Contraction Strains.

By F. C. Edwards.

If it is true that engineering design consists of one part calculation and five parts judgment, we may quite safely assert, *à fortiori*, that in the equation of good casting design, judgment and calculation may be represented respectively as ten to one. That this is by no means an unfair balance of values will, perhaps, be readily conceded when it is remembered that the convenient and much-abused "factor of safety"—generally dependable in the case, say, of mild-steel structures—if applied solely on the basis of more metal, more strength, may produce, in castings, diametrically opposite results to those intended.

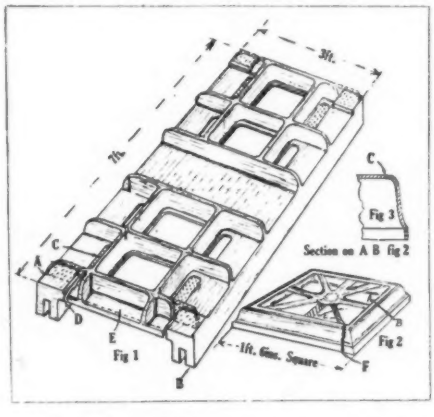
In this sphere, by the way, the wielder of mathematical formulæ is no match for the practical foundryman. The latter's judgment is almost invariably vindicated. It is, nevertheless, frequently undervalued. With regard to contraction strains, in particular, foundry opinion is of infinite value to the designer. It should never be slighted—as is, unfortunately, sometimes the case. It deserves, indeed, to be assiduously courted.

Readers of this journal will probably call to mind cases where patterns have been sent to the foundry, perfect, perhaps, in the eye of the designer, but in which—almost at a glance—fatal sources of weakness have been detected by the foundry chief. By a kind of intuitive perception—the fruit, so to speak, of daily observation and experience—he unerringly indicates, say, the probable line of fracture, and suggests an effective remedy. This, of course, may involve sacrifice in design or expense in subsequent machining. On such a point, however, there is really no room for argument. Though one's pet design be somewhat mutilated, or machining cost be slightly increased, these are obviously lesser evils to face than the probability of a scrap casting, or the likelihood of contraction strains being present in an apparently sound casting. Occasionally, of course, the risk is taken. If the casting flies in cooling, the foundry judgment is vindicated; and it is not necessarily disproved if the casting remains intact.

A striking example of the former case is illustrated in Fig. 1. As will be gathered from the sketch, the pattern was well ribbed, and it was considered to be generally sound in design. On its arrival in the foundry, however, its weak spots were soon detected. On account of the presence of machined facings, A, at the extreme corners, the end transverse ribs were not carried right across, as in the case of the other ribs. To the trained eye it was evident that this shortening of the ribs, taken in conjunction with the comparatively heavy longitudinal bars, B, and the lightening holes, C, constituted a real source of weakness. For various reasons, however, it was decided to make no change in the design.

Exactly as predicted, and in spite of the fact that the side bars were quickly exposed, after casting, to assist equalisation of cooling, the casting gave way at D, but at one end only.

The foundry manager's advice was then acted upon. Holes, C, were filled up, and the ends, E, were made ¼in. thicker. In addition, the ribs were



continued to the outside, as shown in dotted section, to be afterwards machined off. The result was perfectly satisfactory; and no further trouble was experienced with subsequent castings.

Figure 2 is another illustration of the effect of, and remedy for, contracting strains. As is shown in Fig. 3, the metal is only ¼in. in thickness, and there is an internal lip, C, round the top edge. The gates, at their junction with the castings, must be almost knife-edged to avoid breaking pieces out of the frame when they are knocked out. Hence the large number of gates employed—more, perhaps, than some moulders would consider necessary. In addition, of course, they serve as an insurance against the possibility of "cold" metal.

Almost immediately after casting, the two sectioned gates, E, are broken out. This is done to relieve the contraction strain. If this precaution is neglected, the frame invariably flies across one of the corners, as at F.

Enough has been said, perhaps, to show that contraction strains—baneful though they be—can be obviated, but practical experience alone can best furnish the solution.

The Basset Process.—The report of the Société des Aciéries Basset states that while the chemistry of their steel-making process had entirely fulfilled the claims of the inventor, questions as to the form of the furnaces and their linings had presented great difficulties, mainly on account of the exceptionally high temperature prevailing in the furnace. This temperature made possible the obtaining of a product free from injurious impurities, and although it was technically possible to reduce it, the firm did not desire to discard the advantages which it afforded, and consequently attention had been concentrated on the improvement of the refractory properties of the lining. Efforts in this direction had met with a measure of success, and the progress achieved gave the firm confidence that a satisfactory result would shortly be reached. During 1921 the Company had studied the most rational form of furnace corresponding to the various qualities of pig-iron used and steel obtained. Although actual commercial activity had not yet commenced, initial deliveries of metal had been made.

The Development and Manufacture of High-Tenacity Brass and Bronze.*

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from page* 80.)

Tin Brass.

The chief function of tin in brass is to improve the corrosion-resisting properties. In complex brasses of high ductility 0.7 per cent. is the maximum amount that should be used. In naval brass the limit is 1 per cent.

In a series of exploratory casts it was found that the amount of tin that brass will take into solution in the solid state is determined by the Zn. content. In the "alpha" series, the lower the Zn. content the greater the quantity of Sn. which it can dissolve, *e.g.*, an 80/20 brass will dissolve 5.0 per cent., whilst a 70/30 will scarcely dissolve 1.0 per cent. Of the "alpha-beta" series, the standard 59/41 brass dissolves approximately 1.0 per cent. when sand-cast and 1.2 per cent. chill cast, whilst as the Zn. content increases up to 47 per cent. the solubility rises to a maximum of 1.80 per cent. From these results 0.5, 1.0, 2.0 and 3.0 per cent. tin brasses were made of a 59 per cent. copper base. Conditions of manufacture were those outlined for the aluminium brasses, introducing the Zn. and the Sn. as such, last.

Physical Test Results.—These are detailed in Table IV.

Structure.—There is little perceptible difference in the structure of an "alpha-beta" brass containing 0.5 per cent. Sn. and that containing 1 per cent. Exceeding 1 per cent. a brittle Cu.-Sn. compound, resembling the Cu.-Sn. compound, found in ordinary Sn. bronzes, makes its appearance. The effect of this constituent is shown to be similar to the "gamma" compound in ordinary brass.

From these results one cannot regard Sn. in the same light as any of the elements previously considered, it being neither a Cu.- nor a Zn.-replacing element; although, structurally, attempts have been made to consider it as a Zn.-replacing element, giving to it a co-efficient of equivalence of 2.

Iron Brass.

Copper and iron form a heterogeneous series of alloys except at the terminals of the curves. Between these proportions the alloys consist of two constituents, the one rich in iron the other rich in copper. Carbon and copper do not associate in any form, and the presence of C. in Fe. reduces the solubility to any extent that neither steel nor cast iron can be satisfactorily alloyed with copper, but merely exist side by side as a mechanical mixture of one with the other. Zinc readily unites with iron.

TABLE IV.—*Showing the Effect of Tin on the Physical Properties of Brass.*

Series No.	Composition. Cu.	Zn.	Sn.	Fe.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	E. per cent. on 2 in.	R. A per cent.
S.1	59.95	39.38	0.47	0.20	As cast	11.0	26.2	44.0	42.0
					As forged	15.6	28.8	38.0	60.0
S.2	58.90	40.10	1.00	Trace.	As cast	9.6	26.7	32.0	33.5
					As forged	13.6	28.6	38.0	44.6
S.3	58.82	38.76	2.11	0.31	As cast	11.8	26.1	13.0	15.0
S.4	59.17	37.63	2.98	0.22	As cast	16.4	21.25	1.5	3.2

TABLE IV.—continued.

Series No.	Tensile Fracture.	Alternating impact No	Fracture.	Brinell hardness No.	Sclerescope hardness No.
S.1	Fine, stony, silky edges. More or less hackly ..	77	Fine, silky, semi-vitreous	87	13
	Fine, granular, silky edges. Cup and cone ..	113	Fine, granular, semi-vitreous in upper half.	107	15
S.2	Fine, stony, silky edges. Trace of crystallinity existing as exhibited by S.3.	47	Fine, crystalline, with a slight appearance of the laminated crystals exhibited by S.3.	98	15
	Fine, granular, silky edges. Semi-cup and cone ..	107	Fine, granular, semi-vitreous in upper half.	107	16
S.3	Short, coarsely crystalline, consisting of greyish and stony crystals existing alternately	5	Short, grossly coarse laminated crystals.	114	20
S.4	Coarse, alternating grey and stony coloured crystals.	1	Short, coarse, laminated crystals ..	136	23

As Cast.—0.50 per cent. Sn. increases the yield point and maximum stress 2.25 tons and 1.3 tons respectively without affecting the elongation, reduction of area, and alternating impact strength. Increasing to 1.0 per cent. hardens, without strengthening, and impairs both the ductility and impact strength. This embrittlement is naturally accentuated by further quantities of Sn., as in alloys S3 and S4, the latter having little strength and being void of ductility.

Forging.—No difficulties were encountered in the forging of alloys S1 and S2, and worked with the ease of ordinary Muntz metal. The test results of alloys S3 and S4 in the "cast" condition were such that they did not justify consideration in the forged or heat treated condition.

After forging the yield point of S1 is raised 6.6 tons per sq. in., and the maximum stress 2.8 tons per sq. in., but the elongation is slightly reduced. The drop in ductility, however, is not of material importance, the alternating impact figure being raised no less than 15 per cent. Whilst the physical properties of the 1 per cent. Sn.-brass in the "cast" state are inferior to those of 59/41, they are superior after forging, but it is clearly demonstrated that 1 per cent. is the limit of practical utility.

Iron may be introduced into brass by means of a Cu.-Fe. or Zn.-Fe. stock alloy. The preparation of either stock alloys is a comparatively simple operation, if certain elementary chemical laws are observed and manufacture carefully conducted. The first essential in the preparation of a Cu.-Fe. stock alloy is the use of pure iron, not steel, cast iron or ferro-manganese. The iron may be purchased in sheet form as scrap clippings from horse-shoe nails or as Swedish bar-iron. The Cu. should be melted to a good temperature under a suitable slag, and the iron introduced in small quantities at a time up to about 10 per cent. and well stirred. When thoroughly alloyed, the pot should be withdrawn from the furnace, again stirred and quickly poured out into a thin flat mould. Unless this latter precaution is taken, there is a danger of the iron rich material formed segregating in the upper regions of the cast.

Correctly made, a 10 per cent. Fe., Cu.-Fe. stock-alloy is soft, and has a Brinell hardness of 62 against 55 for pure copper and 92 for pure iron.

Johnson recommends the use of a Zn.-Fe. stock-alloy, prepared by immersing strips of clean sheet-iron in a crucible of molten Zn., the temperature of which is maintained for several hours at 800 deg. C., in a muffle furnace. Luting on the

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

crucible lid is suggested for preventing volatilisation.

This method is costly on account of the difficulties of manufacture; moreover, one cannot dissolve, commercially, more than 6 per cent. Fe.; consequently its use cannot be adopted for high-Fe. iron brass of low-Zn. content. Commercial Zn.-Fe. stock-alloys are generally prepared by liquidating the hard Zn. from galvanising works to remove part of the Zn., and then heating the Fe.-rich residue to a high temperature until the desired Fe. content is obtained. The objection to this by-product is its irregular composition and the impurities it carries.

Effect of Iron on 70/30 Brass.

To ascertain the effect of iron on 70/30 brass ("alpha") three alloys were made and designated F, F1, and F2. The first contained 70 per cent. Cu. and 30 per cent. Zn.; the second 69.75 per cent. Cu., 29.75 per cent. Zn. and 0.5 per cent. Fe.; and the last 69.50 per cent. Cu., 29.50 per cent. Zn. and 1 per cent. iron.

The iron was introduced by the 10 per cent. Fe., Cu.-Fe. stock-alloy. No peculiarities or difficulties were encountered either in melting or pouring. The tensile, impact and hardness tests are tabulated in Table V.

In the cast condition 1 per cent. Fe. is shown to raise the yield point from 6.5 to 10.7 tons per sq. in., the tenacity from 16.7 to 24.5 tons sq. in., and the Brinell hardness from 55 to 76 without materially affecting the ductility as measured by both the static and dynamic stress tests. After cold-rolling and annealing, the yield point is raised from 8 to 11 tons per sq. in. and the tenacity from 21.5 to 26.5 tons per sq. in., also without affecting the ductility. The most interesting feature is the beneficial effect of iron on the physical properties in the cast state, whilst the range of physical properties possible from 70/30 brass containing 1 per cent. Fe. is noteworthy, as they give a yield point of 10.7 to 18.5 tons per sq. in., a maximum stress of 24.5 to 41 tons per sq. in., an elongation of 14 to 54 per cent., a reduction of area of 44 to 67 per cent., and a Brinell hardness of 76 to 185.

A series of experiments on the effects of Fe. on malleability—which property was determined by cold-rolling to destruction, cupping and drawing tests—proved that Fe. up to 1 per cent. is not detrimental if correctly alloyed, the intervening annealings correctly performed and the changed physical properties taken to account. Fuller details of these tests are published in the "Metal Industry," Vol. 17, No. 22, page 424.

TABLE V.—*Showing the Effect of Iron on the Physical Properties of 70/30 Brass.*

Mk.	Composition. Cu.	Zn.	Fe.	Treatment.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Alternating impact No.	Izod impact No.	Brinell hardness No.	Scleroscope hardness. No.
F.	69.80	30.20	Trace.	As cast	6.50	16.70	58.00	46.20	79	41	55	15
				Cold rolled and annealed, 650° C. ..	8.00	21.50	68.00	65.00	—	61	57	15
F.1	69.67	29.82	0.50	As cast	8.70	19.40	58.00	47.20	61	49	64	12
				Cold rolled and annealed, 775° C. ..	9.50	22.80	65.00	67.00	—	—	54	10
F.2	69.42	29.57	1.00	As cast	10.70	24.50	50.00	59.30	80	45	76	12
				Cold rolled and annealed, 700° C. ..	14.00	27.00	47.00	62.00	—	63	92	12
				Cold rolled and annealed, 825° C. ..	11.00	26.50	54.00	67.00	—	—	76	12

Effect of Iron on 59/41 Brass ("Alpha Beta.")

The composition of the materials used were similar to those adopted for the 70/30 series, except that the iron was introduced into alloy 1.F.2. by means of a Zn.-Fe. stock-alloy and that 2½-in. sq. ingots were cast instead of 1-in. slabs. The tests results are shown in Table VI.

In ingot form 1.0 per cent. Fe. improves both the tenacity and shock-resisting properties. No further improvement is to be gained by exceeding this quantity whilst the shock-resisting properties tend to fall; particularly is this so in the case of alloy 1.F.2. The low ductility of this alloy, however, is accounted for to some extent by the crystalline form of the impurities introduced by the Zn.-Fe. alloy, and is typical of the troubles encountered when this impure material is used for the purpose of introducing iron.

Hot-working results in an all-round improvement of the tenacity of each alloy, having little influence on the ductility, except in the case of alloy 1.F.2, which improvement is as expected.

Microstructure. — The Fe.-rich constituent appears to be similar in form to that found in the 70/30 brasses, although the limit of solubility seems to be increased. It exerts a similar action on the crystal growth.

Effect of Iron on 53.3/46.7 Brass ("Beta.")

In view of the fact that the hardness of pure iron is similar to that of 59/41 brass, its limitations as a hardener or strengthener will be in brasses containing up to 41 per cent. Zn., and that it will neither effect the tenacity nor hardness of "beta" brasses. Its common use in high

TABLE VI.—*Showing the Effect of Iron on Alpha-Beta Brass.*

Series No.	Composition. Cu.	Zn.	Fe.	Pb.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Fracture.	Alternating impact No.	Fracture.	Brinell hardness No.	Sclerescope hardness No.
1.F.	58.96	41.04	—	—	As cast ..	8.80	24.90	45.00	49.70	Fine, stony, semi-cup and cone.	79	Fine, granular, silky edges.	90	14
					As forged ..	9.60	26.00	47.50	62.00	Fine, stony, silky edges.	87	Fine, granular, silky edges.	90	14
1.F1.	59.37	39.68	0.95	Nil.	As cast ..	9.40	26 80	44.00	44.60	Fine, silky, semi-cup and cone.	95	Fine, silky, semi-vitreous.	90	13
					As forged ..	13.90	28.80	44.00	63.70	Fine, granular, cup and cone, silky edges.	81	Fine, stony, semi-vitreous.	107	14
1.F.2	59.04	38.95	1.56	0.45	As cast ..	11.00	26.80	33.00	30.60	Fine, stony, granular, semi-cup and cone.	31	Fine, stony ..	85	13
					As forged ..	13.60	27.60	43.00	59.30	Fine, granular, cup and cone, silky edges.	49	Fine, stony, inclined to be vitreous.	98	15
1.F.3	59.12	38.36	2.52	Nil.	As cast ..	10.00	26.50	46.00	49.70	Fine, silky, semi-cup and cone.	71	Fine, slightly more silky in appearance than 1.F1.	92	14
					As forged ..	15.80	28.30	39.00	54.60	Stony, granular, uneven.	79	Fine, stony, semi-vitreous.	110	16

tenacity brasses, therefore, must be a question of the manner in which it affects the crystal growth. To investigate this, three alloys were made, and designated 2F, 2F1, and 2F2. The first contained 53.3 per cent. Cu. and 46.7 per cent. Zn., the second 51.5 per cent. Cu., 47.5 per cent. Zn., and 1 per cent. Fe., whilst the last one was made up of 51 per cent Cu., 47 per cent. Zn., and 2 per cent. Fe.

The copper and zinc were adjusted so as to bring each to a similar position in the "beta" phase area of the copper zinc constitutional diagram.

Materials used, conditions of manufacture, and method of casting were identical to those adopted in the 59/41 series, excepting that only the Cu.-Fe. stock-alloy was used for the purpose of introducing the iron.

Mechanical Properties.—Chemical composition and physical test results obtained are embodied in Table No. VII. These indicate Fe. to be detrimental to the ductility in the "cast" state, but beneficial when forged. It will be observed also that forging lowers the yield point but raises maximum stress, increases but the yield point and the maximum stress of alloy No. 2F1 and lowers both the yield point and maximum stress of alloy 2F2 though each was treated similarly and has the same Brinell hardness in both the "cast" and the "forged" condition.

TABLE VII.—*Showing the Effect of Iron on the Physical Properties of "Beta" Brass.*

Mark.	Composition. Cu.	Zn.	Fe.	Pb.	Physical condition.	Y. P. Tons per sq. in.	M. S. Tons per sq. in.	En. Per cent. on 2 in.	R. A. Per cent.	Fracture.	Alternating impact No.	Brinell hardness No.	Sclero-scope hardness No.	No. of crysta grains per sq. cm.
2.F.	53.41.	46.59	Nil.	Nil.	As cast ..	9.00	29.70	24.00	21.50	Coarse, crystalline, exhibiting brilliant lustre.	34	114	15	39
					As forged ..	8.70	32.80	28.00	30.60	Coarse, flaky, exhibiting brilliant yellow crystalline facets, extension uniform over the 2 in. parallel.	49	114	15	488
2.F.1	51.72	47.23	1.05	Nil.	As cast ..	8.00	30.90	16.00	15.00	Fine, crystalline, exhibiting brilliant crystal facets.	9	114	15	1,765
					As forged ..	9.60	33.00	38.00	33.50	Flaky, uneven ..	39	114	15	2,336
2.F.2	50.77	47.03	2.20	Nil.	As cast ..	11.10	33.00	17.00	15.00	Fine, crystalline, exhibiting brilliant crystal facets.	9	114	17	2,314
					As forged ..	8.60	30.60	43.00	44.60	Fine, yellow, almost granular.	85	114	17	2,200

Microstructure.—The mechanical properties of "β" brasses being unaffected by normal heat treatment—both tenacity and ductility being similar, no matter the rate of cooling—the changes responsible for the peculiar test results, which are typical of those obtained from complex "β" brasses, must be attributed to one or all of the following causes:—(1) Internal molecular changes or structural conversion of the "β" constituent; (2) geometrical outline of the crystal grains; (3) the mode of distribution of the free Fe.-rich constituent.

Actual examination proved that iron renders both the internal and external form of the crystal grains more regular, and that this is the principal cause of its embrittling properties in cast brass. Forging, refining and effecting an interpenetration of adjacent crystal grains explains the improved ductility wrought by mechanical work. The effect of the iron rich particles is unimportant, providing they are uniformly distributed and in a fine state of division.

Having established the functions of the third element in the development of High-tenacity brass, the effect of two or more elements in combination will now be considered.

(To be continued.)

Legal Position with Regard to American Steel Mergers.—The U.S. Attorney-General (Mr. H. M. Daugherty) has informed the Senate that in his opinion the proposed merger of the Bethlehem and Lackawanna Steel Companies and the Midvale, Republic and Inland Companies would not be a violation either of the Sherman Act, the Clayton Act, or the Webb Act. He declined, however, to express an opinion whether such consolidations would constitute a violation of the Federal Trade Act.

Manganese in India.

Writing on this subject in the "Engineering and Mining Journal-Press," Mr. E. W. T. SLATER remarks that before the war the greater part of the world's supply of manganese ore came from Russia and India, but, in the last few years, there has been discovered other sources in Brazil, on the Gold Coast of Africa, and in a few other places. Nevertheless, in spite of the competition of the new fields there is little doubt the manganese industry in the first two countries will continue to develop as the demand increases. The Indian fields have proved most useful, and the reports all go to show that the prospects for the future are good. The Indian ore, on account of its hard, lumpy form, is much more suitable for blast furnaces than the more friable ores obtained from the Caucasus; and it is also possible, owing to the better selection, to export a product of more uniform quality than that which characterises the Russian shipments.

The ores from the central provinces are considered to be of the highest grade, while those from Vizagapatam and Mysore belong mainly to the second and third grades. The ores of the first grade have a high manganese content, usually from 49 to 54 per cent. and a moderately high iron—from 4 to 8 per cent. The silica varies from 6 to 9 per cent. and the phosphorus from 0.07 to 0.14 per cent. The second and third grades are characterised by high iron and phosphorus contents and comparatively low silica. Though a good deal of prospecting has been done, there have been no new fields of considerable size discovered in other parts of India, though it is yet too early to say what a more complete survey will reveal. At present practically all the ore mined in India is shipped to Europe and America for conversion; only a few thousand tons are used in India, and this chiefly as a desulphuriser in iron and steel furnaces. With increased development of the iron and steel industry in India, doubtless a larger demand will be made on the supplies, but for many years to come India necessarily will seek a market in the West. Unfortunately the high percentage of phosphorus in Indian iron ore and coke makes the supply not so satisfactory for Indian use as supplies from other parts. But with the improvements in the iron industry, the necessary adjustments will probably be made.

Some years ago the manufacture of ferro-manganese was begun in India in the works at Jamshedpur, and the alloy produced was of the following composition: Manganese 70 per cent., phosphorus 0.55 per cent, and silicon 2 to 3 per cent. The output from one furnace reaches about 80 tons a day. Ferro-manganese is also manufactured by the Bengal Iron & Steel Company, the product having a guaranteed maximum of 74 per cent. manganese and a maximum of 0.55 per cent. phosphorus. It is believed that, with a careful selection of the Indian ores, some real advance may be shown, though, as has been pointed out, new methods will need to be adopted in the blast furnace if India is ever to become eminent as a maker of ferro-manganese. The possibilities of utilising electric energy will have to be carefully considered.

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.*

By Enrique Touceda (Albany, New York).

(*Continued from page 77.*)

Metallurgy of Melting.

All of the author's correspondents and visitors appeared to be very familiar with the reactions that take place in the air furnace. Covering the ground very briefly, it can be stated that the carbon is eliminated mainly as CO. Neither the sulphur, nor the phosphorus, are permanently oxidised, while there will be an increase in the former that may amount to little or much, depending upon the amount of sulphur in the fuel. The silicon and manganese are in part oxidised to silica and manganous oxide respectively, while, unavoidably, some of the iron is being oxidised at the same time, with the result that double silicate of iron and manganese is formed, which if the liming and bottom were inert and no dirt or sand accompanied the charge would constitute the slag. As there is more or less erosion of both sides, walls and bottom, and invariably some foreign siliceous matter introduced with the charge, the slag consists of mixed silicates of iron, manganese, alumina, lime, magnesia, soda, potash, etc., in which the silicates of iron will predominate. In a normal heat the elimination of that part of the silicon, manganese and carbon which is lost, takes place mostly while the charge is melting, and in the absence of very small or thin scrap, will amount to about 28 per cent. of the silicon, from 15 to 19 per cent. of the carbon, and from 40 to 50 per cent. of the manganese, all based upon their original content in the mixture. If it is expedient to use small thin scrap, owing to its lower cost or because it is a by-product of the plant, it should be charged in the molten bath in order that it will be protected from excessive oxidation. While the composition, to which reference has been made, is the one recommended for general use, it is not to be understood that quite wide departure cannot be taken in the case of most of the elements. Some ten years ago attention was rarely, if ever, paid to the carbon content in the product, principally because its importance was not recognised. Inasmuch as the carbon content in pig-iron must have averaged at least as high as 3.35 per cent., and, inasmuch as the sprue must under these conditions have been exceedingly high in this element, it was imperative to run on a low-silicon mixture in order to secure a silicon-carbon ratio that would yield white iron in sections of even medium thicknesses. While to-day it is in no sense unusual to run both thin and heavy castings from the same furnace, at the time referred to this was not considered practical. As a general proposition little thought was given to manganese, which was frequently too low or too high, with the result that many heats of low-silicon, accompanied by low manganese, resulted in the production of a "picture-frame" product, by which is meant a finished product that shows upon fracture an outer surface ring or frame ranging in thickness from 1-64 in. to 1-16 in., or even deeper in exaggerated cases; wholly different in appearance from the metal which it surrounds and separated from it by a sharp line of demarcation. As a matter of fact, this character of fracture, whether resulting from this or other frame-producing mixtures, was so general that the name black-heart malleable iron was given to the finished product, and there is ample evidence to show that it was the aim to obtain this character of fracture.

The author's reason for placing the silicon at 0.90 per cent. and the carbon at 2.35 per cent. is because these figures call for a silicon-content of about 1.25 per cent. and a carbon-content of about 2.70 per cent. in the mixture—limits sufficiently high, on the one hand, to produce a product whose mechanical properties still will be excellent, even if the oxidation of these two elements exceeds their average elimination by a substantial margin; while on the other hand, in the event that the elimination is somewhat less than the average, neither are so high that the product will suffer deterioration in consequence. The fact must not be lost sight of that the percentage of silicon, carbon, and manganese recommended for the mixture is at a point at which, if the furnace is worked normally, the metal will be hot enough to pour by the time the molten bath has arrived at the hard-iron composition decided upon. As has already been indicated, not only is the best design of air-furnace a rather crude affair, but it is not operated by metallurgists. In Fig. 3 is outlined a 20-ton air-furnace designed by the author, that seems to have given satisfaction. Consequently, for commercial reasons, it is well to aim for that composition which safely will admit successfully of reasonably wide variation. With a sulphur content of 0.06 per cent., and other elements balanced, it makes but little, if any, difference at all in either the tensile or shock test, whether the manganese is as low as 0.22 per cent. or as high as 0.30 per cent. While further reference to manganese will be made, the author would point out that, as far as he is aware, there are still some things to learn about this element and the manner in which it is capable of existing. It is a generally accepted fact that, if the manganese is in excess of the amount necessary to unite in theoretical proportion with sulphur to form manganese sulphide, the excess will unite with carbon, and a manganiferous-cementite will be formed instead of the single carbide of iron. However, when graphitisation takes place and is completed, in what form does this excess manganese remain in the finished product?

Phosphorus in Malleable Iron.

Concerning phosphorus, the limit has been placed at 0.20 per cent., because, when in this amount, it does not appear to produce an abnormal appearance of fracture, even in the case of thick sections, at annealing temperatures around 900 deg. C., nor does it appear to lessen strength or ductility. It happens, however, that the limits for the impurities are so interdependent that, for economic reasons, prudence calls for what might be termed a metallurgical safety-factor in the balancing of the different elements. For thin-sections like stove-plate it is well to work on a phosphorus-content of about 0.26 per cent., due to the increased fluidity resulting therefrom, coupled with the fact that the fracture is in no way undesirable.

Slag Conditions.

Leaving this matter as it stands, for the present, there are some hints that may prove of value in connection with the operation of the furnace. The author has already pointed out that the coal-bed should be left undisturbed except to level the bed. He would make the same recommendation in connection with the molten bath of metal, except the necessary disturbance that takes place in hooking into the bath partly exposed pig or sprue, to expedite fusion during the melting-down period; while removal of the slag should be postponed as late as is practical. If machine-cast pig can be purchased as cheaply as the sand-cast, this should be used in preference; while it will be found, if the sprue is partially broken up by means of a light-weight sledge, that, owing to its brittleness, not only can this be done quickly and cheaply, but through this practice much of the adhering sand will be knocked off that otherwise would find its way into the hearth, with the further advantage that the sprue can be charged much more compactly. Every effort should be exercised to prevent foreign

* This Paper was the American Foundrymen's Exchange Paper, and was read before the Birmingham Conference of the Institution of British Foundrymen.

siliceous material from entering the hearth, when this can be accomplished at such little cost. In a test on twelve heats, amounting to a total of 192.8 tons, the slag from these heats, weighed on the same scale, amounted to a total of 12.7 tons, or 6.62 per cent. From this slag there was recovered 5,140 lbs. of metallic iron. At this plant no special precautions had been taken to prevent foreign siliceous matter entering the hearth. It will be found, if such precautions are taken, that a very substantial benefit can be affected by the end of the year through a saving in fuel, in better furnace-control, less slag to wash, and free from iron, etc. If, due to lack of business, it is essential to run the air-furnace at considerably less than capacity, the hearth should be shortened by filling-in with bottom-sand at the rear-bridge, for such a distance as will leave the bath, when molten, almost as deep as when the furnace is being run at capacity; otherwise, due to a shallow bath, the elements will be oxidised to a greater extent than under normal operations.

In determining the space between rear-bridge and roof, to regulate flame-travel, it is advisable at the start to build the top of the bridge slightly too low, securing the final adjustment by bricking-in at each end between bridge and roof, through which procedure the correct area, more quickly and conveniently, can be ascertained, after a trial or two, than through adding or removing a course of brick from the top of the bridge.

Sampling.

In following the progress of the heat it is the general practice to cast what are called test sprues at intervals of about half an hour after the charge has melted. These are broken and the fracture examined, in order to ascertain the rate at which graphitisation is diminishing. In the cooling of these test sprues the practice varies, and it is possible that the fracture, far from enabling one to approximate closely the correct story, can be very misleading. Two precautions must be taken. First, the centre section at about where the sprue should be broken should not be less than about 1⅞ in. dia., and the cooling should not occupy less than about 20 mins. As soon as the sprue has solidified it should be removed from the sand, which should be scraped from the surface. It should be cooled in the air for 10 mins., and then quickly plunged in water and almost instantly removed, this procedure being repeated about every half-minute, allowing the sprue to remain in the water for a slightly longer interval at each dip, and this continued until when again dipped it ceases to create any visible agitation. At this temperature, if broken, it will have the same appearance as if it had not been fractured until actually at atmospheric temperature. If instead of one sprue two are poured at the same time, one being allowed to cool normally in the mould, in order that its fracture can be subsequently compared with the sprue that was cooled in the regular manner for test purposes, it will not be long before an observer can closely estimate and allow for the effect produced by the drastic cooling. If the cooling of the test-sprue be carried out in this manner it can be stated that for castings with sections as thick as ⅞ in. no danger need be anticipated, that primary graphite will be present if in the sprue last taken the fracture shows clear, except for the presence of a few minute specks of graphite very sparsely disseminated throughout.

At this point a few words in connection with the castings as cast may prove pertinent. If owing to the use of a poor consignment of fuel, to neglect or bad judgment on the part of the furnacemen, a heat is delayed and an undue amount of silicon, manganese, and carbon eliminated, this can be detected by the sudden stickiness and sluggishness shown by the metal as it is being poured from the test-ladle, also by the appearance of pin-holes at different places on the periphery of the very thin rim of the test sprue. While castings from such a heat would, when annealed, have a picture-frame or an all-steely fracture, dependent upon how badly oxidised the metal, the heat can be saved if promptly treated by a silico-spiegel addition, or an addition consisting of a combination of ferro-silicon, ferro-manganese, retort-coke, and iron-borings bonded in briquette form, the borings being added to give increased weight to the mass in order that it will sink into the molten bath as far as possible. It can be stated that, through close observation, almost any over-oxidised heat may be saved in this manner.

But whether the castings are derived from a heat of the composition recommended, from a heat from which a greater amount of the oxidisable elements have been eliminated than in the case of the former, or from one in which the carbon particularly borders on the higher limit, there are certain practices concerning which the author would hesitate to make mention were it not for the serious losses sometimes occasioned through neglect to observe precautions of so obvious and commonplace a nature. At times complaints have been received concerning the heavy losses resulting from the checking and cracking of castings. With the knowledge possessed by the foundrymen that the lower the carbon the less fluid, and the higher the contraction of the molten air-furnace iron, he is prone to attribute such losses when extraordinarily heavy, wholly to the fact that in the effort to obtain high-tensile and ductile metal, the fluidity and contraction of the iron have been adversely affected through the use of a low-carbon composition.

In his examination of some of these complaints, the author has found conditions, entirely apart from composition, that have actually invited this character of trouble. Owing mostly to failure on the part of the engineer-designer to co-operate with the foundry engineers, the foundry is called upon to make castings from patterns of intricate design and of unreasonably disproportionate sections and not infrequently from poor pattern equipment.

Hard-iron castings of this description must be in a state of severe strain even when allowed to cool in the mould, and much more so, when cooled as evenly as is commercially practical, while the design may be so unnecessarily faulty, that even under test conditions of commercial practice the loss from cracks and checks may prove prohibitive in certain cases, and much too high in others. If the foregoing is true, what can be expected in the many cases that have been seen in which the castings have been stripped a few moments after solidification, with half of the castings buried in the still very hot sand and the other half exposed to the draughts of the foundry atmosphere. Not infrequently there will be seen a labourer wetting-down the sand on a floor adjacent to the one where the castings have just been stripped, and as he playfully looks around, the nozzle of the hose will partially swing around and drops of water will be sprayed over the red-hot castings, with the development perhaps of a check where each drop fell. Obviously, as the carbon is gradually lowered, both fluidity and contraction are adversely affected, but the author believes that there will be found to be little difference in these properties as between a carbon content of 2.50 per cent. and 2.35 per cent., but a more consequential and serious difference between a content of 2.35 per cent. and 2.00 per cent. While no manufacturer aims to run as low as 2.00 per cent. carbon, this figure accidentally may be reached when aiming to run on a content of 2.35 per cent. The point the author would bring out, is that from complaints investigated, he is forced to conclude that carelessness has contributed more to heavy crack and check loss than has a low carbon-content.

In the foregoing remarks on the air furnace, no efforts have been made to cover anything aside from the "high spots." With few exceptions, this is the furnace used in the States, owing to its cheapness and its simplicity of construction and repair. The open-hearth is much more costly to build, with the net result that no fuel economy results from its use owing to the fact, not that it it is not a more efficient melting apparatus, but that it must be kept hot when not in operation in order to prevent the spalling of the silica brick. The author does not believe that the use of the electric furnace is warranted, except perhaps in very large installations. There is no advantage to be gained in running on a very low-sulphur-phosphorus content, but quite on the contrary many disadvantages.

The Annealing Process.

In order to prepare the hard-iron castings for heat-treatment they are barreled until free from

adhering sand and then trimmed. They are then placed in receptacles called pots or rings of the shape of a band in that they have neither top nor bottom. A ring is placed on a stool of solid iron about 3 in. thick and somewhat larger in perimeter, on the bottom of which are lugs about 5 in. high that serve as feet, and which are so spaced as to admit of the lifting fork of the charging truck being introduced beneath the stool. This ring is then filled with castings which are surrounded with a packing, the nature of which will be entered into later.

Another ring is placed upon the first one, and the process continued until four or five rings have been used, the entire assemblage being called a stand. These stands are then picked up by the charging truck, the best and most convenient form of which is the electric, and taken to the heat-treating oven, where they should be placed in straight rows, the row nearest the side wall being spaced at least 5 in. from it, and a space of 4 in. between the other rows. No mistake could be greater than to jam the stands close together, as it is of prime importance that heat circulation be given its greatest opportunity. The castings are surrounded with a packing for the purpose of preventing kiln-warp, and for the purpose also of furnishing an oxidising pot-atmosphere that will facilitate the decarbonisation of the metal. The latter object has been given an exaggerated importance as far as present-day practice is concerned.

In the old days, with castings having a carbon content of 3 per cent. or over, this may not have been the case, but with the carbon content now present a very strong packing is a mistake rather than otherwise. Even a packing of sand, if properly sized, will hold enough air to admit of all the oxidation necessary to produce a superior product. The really important matter is to have a packing preferably containing about 10 per cent. of iron oxides, the balance being of an inert character of the nature of slag, or other material that will have little tendency to combine with the oxides of iron at the temperature of anneal. The latter condition is important in order that there will be no tendency for the packing to lump, and in order that the casting readily can be shaken out clean and free from adhering packing. As a matter of fact, in muffle ovens of the very tightest construction, in which castings are packed solidly, so that the only unoccupied space in the muffle results from the voids occasioned by the castings, the decarbonisation is as complete as in the case of the strongest packing now used, as can be seen from Table I., which have reference to three test-bars selected on the authors last visit to a plant where no other type of oven is used.

Table I.—*Showing the Analysis and Physical Tests of Malleable Irons treated in a Muffle Furnace.*

Analysis of Hard Iron.

Mark.	Si.	P.	S.	Mn.	C.C.
1	0.76	0.193	0.050	0.200	2.13
2	0.88	0.180	0.051	0.230	2.26
3	0.80	0.190	0.049	0.200	2.37

Physical Test.

Mark.	M.S., tons per sq. in.	E., per cent. on 2 in.	R. A. per cent.
1	26.5	36.7	38.0
2	26.1	35.9	33.2
3	25.8	25.7	30.1

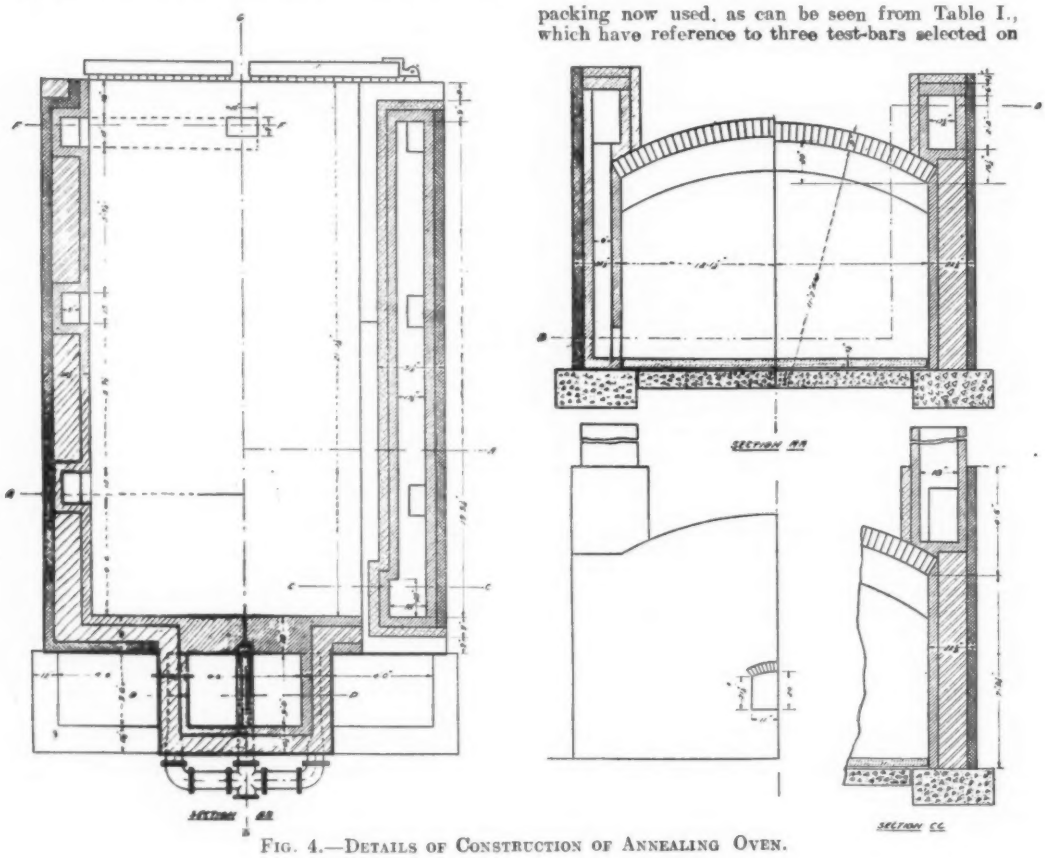


Fig. 4.—Details of Construction of Annealing Oven.

If castings are being made that are not liable to warp, the muffle-oven is the type to build. The best construction of muffle is by the use of the Manion type of brick. This brick is thin, but reinforced by webs that serve for the most part to carry the load, with the result that the heat can be transmitted to the inside of the muffle quickly and economically.

If the muffle is made of carborundum-brick a very strong and lasting muffle will result, through which the heat can be transmitted some six times more quickly than through a clay-product. These bricks are very expensive, and many have been deterred from their use on this account. A number of those who have consulted the author have been very sceptical in regard to the character of product that can be derived from the muffle oven. In order to quiet any who may feel likewise it can be stated that in the Association of which the author is consulting engineer one of the members makes use of the muffle-type oven only, and their record for quality is amongst the highest. As can be gathered from the tensile tests quoted in Table I., which happen to be considerably higher than their average, their product is not excelled by that of any

of the other. These particular results are quoted simply by way of illustrating what can be accomplished in the muffle oven. The product made by this particular concern will average about 24.1 tons per sq. in. ult. strength and run somewhat over 20 per cent. in elongation.

The Heat Treatment of Malleables.

As stated, in order to obtain a product high in tensile strength and ductility, the composition of the hard-iron castings must be restricted to within certain limits. Assuming that castings are being heat-treated that correspond to these composition requirements, it can be stated that, in order that their conversion into a product that is both strong and ductile, be complete and satisfactory as far as structural conditions are concerned, the castings preferably should be held at a temperature about 100 deg. F. (37 deg. C.) above the critical-range for a period of not much less than 60 hrs., and cooled at a rate of 10 deg. F. (5 deg. C.) or less per hour, until their temperature has fallen to about 100 deg. F. (37 deg. C.) under the critical-range, after which the cooling gradually can be accelerated. It is one thing, however, to possess an accurate knowledge of exactly what should be done in order that the best heat-treating results will follow, and another to construct commercial apparatus in which a large quantity of material can be heat-treated in conformity with the rules that are prescribed. Some few years ago not only were most of the plants lacking in a metallurgical knowledge of the process, but the apparatus was of such a faulty character that it was impossible to carry out in an effective manner what research had shown was essential if the superior product was to be obtained. In short, it often is much easier to indicate than to achieve, and while general instructions can be sent out as to the proper temperature at which to convert, the length of time to hold at temperature, and the rate at which the cooling should take place, this will prove of little avail if the heat-treating ovens are so constructed that proper thermal conditions exist in only a restricted area of the oven, and that the oven as constructed cannot be cooled at the rate designated.

Essential Features of Annealing Ovens.

Space will not be used for recounting the conditions that prevailed, but a brief attempt will be made to cover certain facts that must be considered in annealing-oven design. First of all, each oven should be self-contained in all particulars. The general method, almost universal some few years ago and in no sense uncommon to-day, of building a battery of 8 or 10 ovens with common side-walls and a common stack is a serious mistake from many points of view. One can well imagine the unbalanced thermal conditions that must obtain when, as very frequently happens, two contiguous ovens are under fire but the one at their other side cold. In such cases the common side-wall of the two under fire is not exposed to the atmosphere, and consequently is radiating off no heat to it, while the other side-wall is doing so at a rapid rate. Without wasting words to prove the general worthlessness of such construction, it briefly can be stated that from the standpoint of cost, maintenance, and control, this system could not be worse. Rigidity of construction is one essential that is fatal to overlook. If the ovens are not rigidly built cracks will develop and it will be difficult, and perhaps impossible, to cool the oven from temperature at the rate desired. The walls should be at least 22½ in. thick, encased on the outside with steel or iron plate, and the whole reinforced by a system of buck-stays set about 30 in. between centres where this is possible.

The walls and doors should be so thoroughly insulated that when the oven is at temperature the hand can be pressed against the plates without undue discomfort. The floor as well should be insulated and, for reasons to which we will refer later, so should the front half of the roof. The fire-pot of an oven should be on its outside and not within it, as the oven proper is designed to heat-treat castings and not for the purpose of burning coal. With the fire-pot on the inside and, as frequently is the case, located at one corner only, it is not an easy task, if at all possible, to

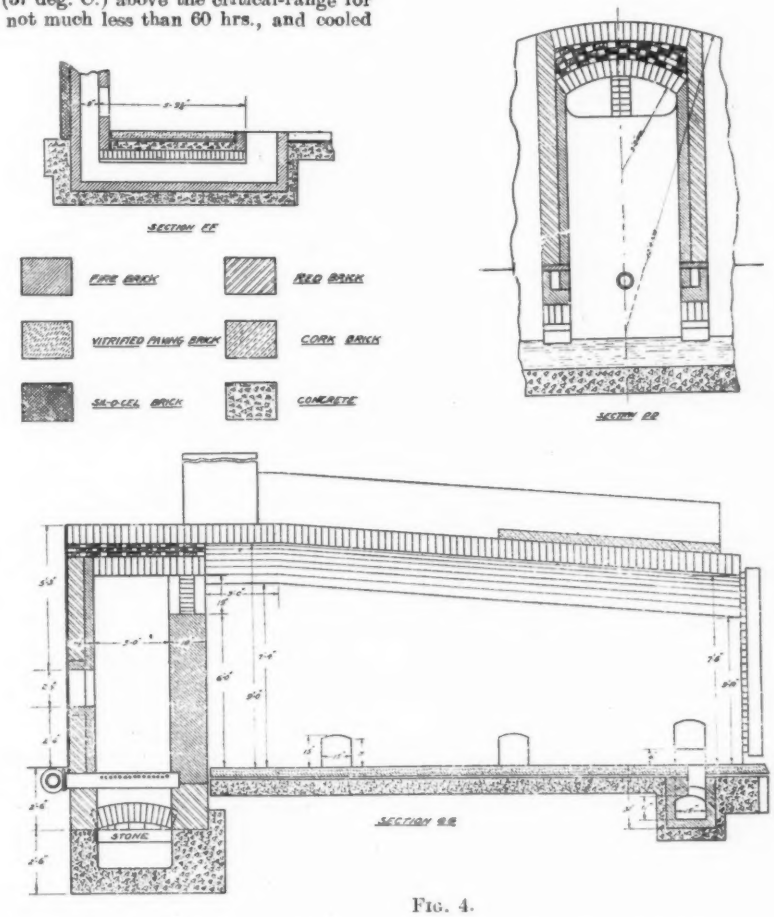


FIG. 4.

obtain heat uniformity within the oven, which statement holds true even in the event that a fire-pot is placed within the oven at diametrically opposite corners. The floor should be built solid, with no underground flue system beneath it. The latter construction is of no benefit as far as a saving of fuel is concerned, and with a complicated under-floor flue system—now being generally discarded as new ovens are being built—the cost of this part of the oven equalled if not exceeded that of the rest, while owing to the jar produced by the loaded charging truck and the combined weight on a floor subjected to such a high temperature the maintenance cost is heavy. No underground flues are necessary aside from one small stack-flue on each side of the oven, which preferably should be located on the outside, as close as practical to the side-wall footings. In the last few ovens designed by the author he has placed one stack-flue and one small stack on top of each side-wall, the bottom side-wall flue-openings being connected with these stack-flues by a vertical flue built within the side-wall.

In this manner not only is all underground flue work avoided, but as the entire system is exposed the flues can easily be kept clean and tight. The ovens are built in rectangular form, width and length in the ratio of about 3: 4. The fire-pot is located on the outside, midway between the side-walls, and is constructed on the gas-producer principle, that is, there is a water seal, air bungs through which about 400 cub. ft. of air per min. against a 5 oz. pressure is admitted, a more or less deep bed of coal resting on ashes that reach from the floor of the seal to about 1 ft. above the bungs. Between the actual roof of the fire-pot and the fire is a false arch, and between it and the roof chequer work of brick through which hot secondary-air for combustion of the combustible gases is drawn. These details are set out in Fig. 4. The opening from fire-pot to oven, that is, the bridge, is located as high as possible in order that combustion will start to take place right in front of the chequer work and at the point where the roof of the oven proper slants towards the front. Through the use of a slanting roof the bridge can be located so high above the top of the stands, where the temperature is obviously the hottest, that no danger exists in over-heating the castings in the topmost ring of the stand, while as the flame advances towards the front of the oven and its temperature drops by the amount imparted to the castings at any section, the roof is lower, and consequently a very close heat balance is maintained until the front of the oven is reached. There are three side-wall flue-openings at the floor-line, leading into the vertical flues that go to the stack-flue, with openings so proportioned that the heat of combustion is drawn to different parts of the oven in a very uniform manner, the adjustment being made by means of a draft-gauge in such a manner that the draft in the two front flue-openings is strongest but equal on each side, the next two less strong and equal on each side, and next still less strong and equal on each side. By means of this gauge and a pyrometer the adjustments can be made after some three or four anneals have been run.

(To be continued.)

Chemical Works Regulations.—The Home Secretary has issued, under date July 11, Regulations applicable to the manufactures and processes incidental thereto carried on in chemical works.

Protection of Steel Industry in Australia. — Outspoken remarks characterised the reply given by the Prime Minister (Mr. Hughes) to a recent deputation from the Australian Workers' Union, asking for further protection for the steel industry for about 18 months. Mr. Hughes asserted that it was not sufficient solely to protect an industry. There should be some assurance that the protected products would be bought. A duty of 100 per cent. could be placed on steel, but even then no one might be able to afford to give orders for the local material. England was producing steel despite the higher wages paid there as compared with those paid to German workmen, and he was sure that the difference in wages as between England and Australia was not so great as to account for the inability to produce steel locally. Mr. Hughes asked his hearers to place all the facts before the Tariff Board, which was a body clothed with extraordinary powers, and whose recommendations Parliament would not venture to disregard.

Trade Talk.

Bowers & Company, mechanical engineers, have removed from 37, Joseph Street, to 22, Bolton Street, Bradford.

Ball Brothers, ironfounders, of Stratford-on-Avon, have appointed Morse & Taylor, 124, Victoria Street, S.W., as their London agents.

The Joseph Dixon Crucible Company have removed from 28, Victoria Street, S.W.1, to 22, Duke Street, Stamford Street, London, S.E.1.

The Wooler Engineering Company, Limited, are being wound up voluntarily, with Mr. R. Stephens, 31, Lombard Street, E.C., as liquidator.

Steele Sellers & Company, iron and steel merchants, have removed from 5, Cathedral Yard, to 116, Cheetham Hill Road, Manchester.

The Brightside Foundry & Engineering Company, Limited, have removed their Newcastle branch offices from 14, Grainger Street, to 8, Oxford Street.

The Western Electric Company, Limited, have appointed Lionel Robinson & Company, 3, Staple Inn, W.C.1, sole selling agents for London, Middlesex and Surrey for their B.A.G. diffusers.

Mr. C. J. H. Carr Evans, Suffolk House, Laurence Pountney Hill, London, E.C.3, has been appointed British representative of P. Scholler & Sons, wire meshing manufacturers, of Hamburg.

Mr. L. F. Richardson, formerly connected with White Bros. Engineering & Machinery Company, Limited, Stratford, London, E.15, has established himself in business as a machinery dealer.

Ash & Lacy, Limited, Globe Galvanising Works, Great Bridge, Tipton, have appointed Morris Ashby, Limited, of 6, Chapel Street, Liverpool, as their selling agents in Lancashire and Yorkshire.

Messrs. John Cashmore, iron merchants, of Great Bridge, Tipton, Staffs., have purchased further obsolete war vessels, including a cruiser, two destroyers, and a submarine, for breaking-up purposes.

Considerable damage was caused by a fire which broke out at the works of Cochrane & Company, Limited, Cargo Fleet. The fire originated in the pipe-cutting shop, a building 45 ft. by 42 ft., and the foundry and pattern store were also damaged by fire.

The Mannesmann Tube Works, Burbach, Sarre, of which Engineering Supplies, Limited, Mansion House Chambers, 11, Queen Victoria Street, London, E.C.4, are the British representatives, having come under French control, will in future be known as Les Acieries et Usines a Tubes de Sarre.

The exhibits of Nobel Industries, Limited, at the Brazilian Centenary Exhibition, 1922, will be of a varied and interesting nature, contained in one large showcase. Generally speaking, the samples of Nobel products are exhibited under four heads—explosives, ammunition, metal goods, miscellaneous.

A. P. Townsend, iron, steel, etc., merchant, Exeter Buildings, Suffolk Street, Birmingham, has been appointed sole agent in the Midlands, Yorkshire, and South-West England, for the Dafen Tinplate Company, Limited, Llanelly, for tinned sheets, churn sections and circles, terne and lead coated steel sheets, and P.C.R.C.A.'s

Lawson, Walton & Company, Limited, 2, St. Nicholas Buildings, Newcastle-upon-Tyne, have established a foundry demonstration store and exhibition. This permanent exhibition will enable local foundrymen to inspect the various plant, equipment, stores, requisities, etc., necessary to the economical production of castings.

The Morgan Construction Company, of Worcester, Mass., U.S.A., have supplied eighteen additional Morgan producer gas machines to the Bethlehem Steel Company, Bethlehem, Pa., making a total of sixty-four erected at the Bethlehem works. The International Construction Company, Limited, 56, Kingsway, London, W.C.2, are the manufacturers of these machines in great Britain.

The Royal Metal Trades' Pension Society will in future be known as the Royal Metal Trades' Pension and Benevolent Society, the operations of the Society being extended to convalescent home treatment. The board of management have power to increase the pension to fifty guineas per annum, while females engaged in the trades are to receive consideration in accordance with the merits of the case.

The tender of Messrs. George Cohen, Sons & Company, Commercial Road, London, E., for the present accumulation and any quantities arising for a future period of at least six months of the surplus empty shells, scrap, etc., has been accepted by the Disposal and Liquidation Commission. The material is at present stored at various Government depôts throughout Great Britain, and clearance will commence almost immediately.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Training of Foundrymen.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—"Equality of opportunity" appears to be the keynote of the suggested scheme for the training of foundrymen, outlined in the Paper given by Mr. A. A. Liardet, and reported in THE FOUNDRY TRADE JOURNAL, and if something on the lines suggested is carried into effect the foundryman of the future should worthily uphold the traditions of the industry, which nowadays are in danger of suffering an eclipse.

In engineering generally "equality of opportunity" is by no means pronounced, for the "pupil" and the "apprentice" are still separate and apart, and the future of the former differs considerably from that of the ordinary trade apprentice. Merit tells, but only to a limited degree, for the pupil is destined for a position, no matter how low may be his qualifications, whilst the apprentice, handicapped by the limited range of activity permitted by his training, is debarred from making a bid for position, and must perforce resign himself to the *rôle* of subordinate. In other words, one is trained to manage and control, whilst the other is trained to produce.

That this is an anomaly which should be discarded is recognised by many who have the interests of industry at heart, as well as the interests of the rising generation. When system prevents the exploitation of capabilities, by refusing the necessary facilities, it is injuring, not only the man, but also the industry with which he is associated. The man, by reason of his training, may be a sound and skilful workman, and as such is an asset to industry: but if his early opportunities had been more open, he might to-day have been an efficient manager, and a still greater asset.

"By merit alone shall he rise" should be the dictum employed, and no one will quarrel with the assertion that the development of proficiency will do much to allay industrial unrest. The workman, trained as a workman, must of necessity think and act like one, because he has not been trained to think and act differently, and he is proficient only as a workman. With better opportunities he might have done better, but as it is he must remain in the position for which he is fitted, and he grouses and kicks accordingly.

If the training of foundrymen is conducted on the lines suggested the "cinderella of the engineering industry should soon attract, and not repel; for even if, in the first instance, the boy does not appreciate the opportunities offered, the advantages to be derived will not be lost sight of by the parents. The mechanic (or foundryman) will see in this an opportunity for his son which was denied the parent, and will instil into the mind of the boy the advantages to be derived from constant application. No longer will the boy enter industry with a view to qualifying as a journeyman, but with a view to ultimately becoming a power; and even should he fail in after life to reach a high position, the training received will have broadened his outlook, and the bitterness of thwarted hopes and aspirations will not find expression in grumbling discontent with his lot, because he will know that the failure is his, and that he had the opportunity to do better.

The suggested probationary period of two years may have advantages, but it has its pitfalls also. The fact of being irrevocably bound for a number of years is apt to make the task distasteful, which prevents, to some extent, the development of capabilities, and the period of probation is presumably devised to allow the subject to retain freedom of action in embracing a career, by permitting him to take a more or less detached view of the surroundings. It may be said at once that this is a most critical period, and if the boy can stand the first two years of foundry life he will have no wish to relinquish that life at the end of the period. It is during that period that the determining factors are at work, and it behoves those who are responsible for the training of the boy to use this period for educational purposes of a practical nature. There is just as much danger in allowing the probationer too much freedom as there is in allowing him too little, and if he would be kept interested he must have something definite to do. He must feel, at a very early date, that he is part of the organisation, and that something depends upon him. If he is ignored, or left to shift for himself, his interest will speedily evaporate, and everything appertaining to foundry work will appear distasteful. The scheme is, however, a practical one, and deserves unqualified support.—Yours, etc.,

W. J. HISCOX.

London.

Gazette.

A WINDING-UP ORDER has been made against the Clarendon Manufacturing & Engineering Company, Limited, 20, Copthall Avenue, London, E.C.

A RECEIVING ORDER has been made in connection with the affairs of Mr L. I. Thomas, lately trading as the Valley Tinplate & Metal Company, 89, Taff Street, Pontypridd.

MESSRS. J. T. BANNER and G. F. Guy, iron, steel and mineral merchants, 31, Queen Street, Wolverhampton, have dissolved partnership, each partner in future carrying on business separately.

THE PARTNERSHIP heretofore subsisting between Messrs. G. F. Johnson, W. Barras and W. Barras, engineers, Piccadilly, Shipley, Yorks, under the style of the Airedale Engineering Company, has been dissolved. Mr. Johnson continues.

THE names of the undermentioned companies have been struck off the register of Joint Stock Companies, and such companies are dissolved:—British Sherardizers, Limited; Clayton Metal Company, Limited; Colonial Engineering Agency, Limited; Crescent Minerals, Limited; Denton Electrical Construction Company, Limited; Electro Galvanizers, Limited; Holmquist Electric Company, 1911, Limited; Humphris Engineering Syndicate, Limited; Humphries Patent Gear & Engineering Company, Limited; Leyton Engineering Company, Limited; Loughborough Ironworkers, Limited; Medina Engineering Company, Limited; North Stafford Silica and Minerals, Limited; Pioneer Engineering Syndicate, Limited; Reynolds Steel Inventions, Limited; Standard Turbine Company, Limited; Suffolk Iron Foundry Company, Limited; Victoria Stamping Works, Limited; and Woodward-Weddell Steel & Engineering Company, Limited.

Obituary.

MR. B. WARREN, of Warren Bros., boiler makers and colliery engineers, died on July 8, aged 65.

MR. W. R. J. GRIFFITHS, engineer, of Gungate, Tamworth, died recently at the age of 61 years.

MR. H. E. MERRY, engineer under the Swansea Harbour Trust, has died at his residence, 32, Carlton Terrace, Swansea, at the age of 37.

MR. JAMES DURRANS, of James Durrans & Sons, Limited, manufacturers of foundry requisites, Phœnix Works, Thurlstone, Sheffield, died on July 15, in his forty-seventh year.

SIR JAMES BROWN MARSHALL died at his residence at Southsea on Saturday last. The deceased from 1906 to 1917 was Director of Dockyards at the Admiralty. He joined the board of Messrs. John Samuel White & Company, Limited, shipbuilders and engineers, at Cowes, five years ago as deputy chairman, and was afterwards elected chairman of the board. He was born at Portsmouth in 1853, and started life as an apprentice in Portsmouth Dockyard in 1867.

MR. ROBERT READHEAD, of South Shields, a well-known Tyneside shipbuilder, died on July 24 after a long illness. Mr. Readhead, who was in his 79th year, was the son of the late Mr. John Readhead, founder of the firm of John Readhead & Sons, Limited, shipbuilders. Marine engineering constituted his business career. He served an apprenticeship to that trade, and when, in 1865, his father founded the firm which has since become that of John Readhead & Sons, Limited, shipbuilders, engineers and graving dock owners, he was associated with it. For many years he was head of the engineering department, besides becoming one of the directors of the concern in the progress and development of which he took a prominent part.

IRON AND STEEL MARKETS.

Pig-iron.

Movements in the various pig-iron markets, as usually experienced at this period of the year, are restrained by the holiday influences, and business all round is quiet and uneventful. In the Midlands, consumption of pig-iron continues on a restricted scale owing to the general slackness in the foundry and finished material sections, in which, unfortunately, unemployment or short time working is still the rule. Buying in this district is consequently confined to immediate requirements, consumers hesitating about placing forward orders in the hope of securing some concession in prices when the revised railway rates come into force. Makers, on the other hand, contend that current market prices are unremunerative, and that the small advantage derived from the reduction of transport charges will not permit further concessions in the direction desired by buyers. In the Lancashire area rather more activity is noted in demand, foundries working on textile machinery castings having a fair volume of orders in hand, but otherwise business is quiet and consumption of pig remains at a very low average. Prices for Derbyshire No. 3 foundry, however, continue firm at previous quotations. On the Cleveland market conditions continue inactive, with few indications of a marked improvement in the near future. The home demand of late has been much below expectations as the result of the reopening of the engineering works, while the inquiry for export has also decreased in volume owing to the instability of the foreign exchanges. During July shipments of pig-iron from Tees-side ports have marked a decline as compared with June, the aggregate showing some 10,000 tons decrease in that period. So far, the restoration of freedom in price adjustments in the Cleveland market has had very little effect upon quotations. No. 3 G.M.B. is generally maintained at 88s., with No. 1 and silicious firm at 95s., while No. 4 foundry is a shade easier at 87s. to 87s. 6d., No. 4 forge 85s., and mottled and white 80s. Purchases of ferro-manganese have been fairly extensive of late on American account, but there has not, as yet, been any development as regards foundry qualities in that direction.

The East Coast hematite market has undergone no improvement since previously reported, and stocks are now accumulating heavily. The arrangement between some of the local makers, by which the price of mixed numbers has been held at 94s. per ton, has now been modified to bring the quotation to 93s., but it is said to be possible to buy well inside these figures from firms outside the agreement.

Finished Iron.

In this section of the trade very little improvement can be recorded, the number of works still on short time evidencing the unsatisfactory conditions now affecting the industry, for which, at present, there is no relief in sight. In South Staffordshire also Belgian competition is again becoming active, makers in that country now offering nut and bolt bars at cut prices, with the result that home manufacturers have had to shade quotations in order to obtain business. The anomaly in prices of crown bars continues, some makers still adhering to £11 15s., and obtaining it for all the iron of this quality they sell, although the quantity is not large. Generally, however, the quotation for this quality is £11, and in some cases it is reported that that price is not firm. Transactions depend entirely on circumstances. Scarcity of orders may reasonably induce makers to grant concessions to keep works running, while those better placed for specifications are in the position to maintain firm prices. The foundry industry is also passing through an anxious period, but in this case hopes are confidently entertained that accelerated activity in the engineering branches may bring a speedy revival in the demand for castings. Wm. Whitwell & Company have reduced their prices of bar iron to £11.

Steel.

With the near approach of the holiday month business in all departments of steel production has slackened to some extent, although a steady stream of inquiries inspires optimistic anticipations of more favourable trade developments towards the end of August. At the moment, however, new orders are the subject of keen competition among steel makers, many of whom are, unfortunately, beginning to feel the financial strain of a prolonged spell of idleness, significantly expressed in the figures of balance-sheets issued by many well-known firms, and dividends reduced or passed for the current year. In the heavier branches of the industry the delayed action of the companies in placing the long-expected orders for railway material has a restraining effect upon employment in the mills, forges and foundries, but these conditions it is hoped will soon be improved as renewal of stocks in that direction must now be a matter of urgency. Increased activity in the electrical industry is, however, a satisfactory feature in the position, the principal Lincoln firms in this line having substantial contracts on hand, which will entail some good orders for steel material. The placing of the Admiralty contracts for new battleships is also arousing interest among steel makers, Tyne shipbuilders and engineers awaiting instructions to tender for the new battleships and keen competition is expected. Armstrong, Whitworth & Company, Palmers Shipbuilding Company, and Swan, Hunter and Wigham-Richardson will tender, as will also R. & W. Hawthorn, Leslie & Co., and Parsons & Company. In South Wales the steel works are busy, but are anxious to increase their bookings. The Association price for steel sheet and tinplate bars is unchanged at £7 7s. 6d. The fixing of a price of £7 15s. for the Midlands has not been a success, owing to outside competition, and several orders have been lost by South Wales makers. Steel rails are very quiet, and the bulk of the business done has been in light rails.

Scrap.

In common with other raw materials, the markets for scrap are passing through an exceptionally quiet period, consumers restricting buying to parcels required for immediate necessities. On Tees-side heavy steel scrap is in slightly better demand, but material of the right sort is not plentiful, and the price is firmer at about 62s. 6d. per ton delivered at works. In other descriptions business is more or less stagnant, and prices are purely nominal as under, all delivered works:—Heavy cast-iron machinery scrap in handy pieces, 79s. to 80s.; steel turnings and cast-iron borings, each 45s.; heavy wrought iron, bushelling and piling, scrap, each 62s. 6d.; special heavy forge, 70s. to 75s. per ton.

Tinplates.

A somewhat easier tone has been in evidence in the tinplate market during the current week, but values, on the whole, have been steadily maintained. The export trade continues quiet all round, but buying on home account shows a fair average volume of business passing. Standard sizes are now quoted:—Coke tins, IC. 14 x 20, 112 sheets, 108 lbs., 19s. 6d. to 19s. 7½d. per box; IC, 28 x 20, 112 sheets, 216 lbs., 39s. to 39s. 6d. per box, net cash, f.o.b. Wales, the higher figures being asked for prompt shipment. Wasters are in quiet steady demand, with few variations from previous quotations.

Metals.

Copper.—In view of the impending holiday season business in the markets for base metals has tapered off to a considerable extent, and with relaxed pressure of buying transactions have in general been confined within narrow compass. Notwithstanding the conditions thus outlined, the tone of the standard copper market has held firm, and with consumers showing an increased disposition to buy forward, more activity in dealing is promised in the near future. Labour disturbances in the States have had a depressing effect upon business on that side, but the tone in the New York market continues steady, with a fairly substantial demand, which, eventually, must have the effect of considerably reducing stocks recently accumulated. Current quotations:—

Cash: Wednesday, £63 7s. 6d.; Thursday, £63 12s. 6d.; Friday, £63 17s. 6d.; Monday, £64 5s.; Tuesday, £64 12s. 6d. *Three months*: Wednesday, £63 12s. 6d.; Thursday, £63 17s. 6d.; Friday, £64 2s. 6d.; Monday, £64 7s. 6d.; Tuesday, £64 15s.

Tin.—An outstanding feature in the week's transactions in standard tin has been a revival of buying on speculative account, with almost daily advances in values, the anticipated disposal of stocks in the East not apparently having materialised. It had also been feared at one time that the American coal and labour troubles would affect the market, but it is now expected that the American deliveries will turn out well for this month, and there continues to be influential buying of the metal. Owing to pressure in near positions the premium on forward tin has now entirely disappeared. The Straits shipments this month are

expected to be considerably smaller at about 4,500 tons. The latter factor will, of course, have an effect upon the statistical position of which the figures for the past month may be more favourable than market expectations. Current quotations :—

Cash : Wednesday, £160 5s ; Thur day, £162 15s. ; Friday, £161 10s. ; Monday, £162 10s. ; Tuesday, £162 15s. *Three months* : Wednesday, £160 5s. ; Thursday, £162 15s. ; Friday, £161 10s. ; Monday, £162 10s ; Tuesday, £162 15s.

Spelter.—Better buying of the metal by the galvanising industry of late has had a stimulating effect upon the spelter market, and prices are firmly upheld. Supplies of electro are again restricted, and here again values have again appreciated. The American position continues strong. Current quotations :—

Ordinary : Wednesday, £29 17s. 6d. ; Thursday, £30 7s. 6d. ; Friday, £30 10s. ; Monday, £31 ; Tuesday, £31 10s.

Lead.—The stringency in soft foreign pig remains unabated, and backwardation is once more much in evidence Little metal is available for export, and Continental consumers are consequently mainly dependent on supplies from Spain and Australia. More business in sheet and pipe lead has been done with the building trade, while the cable manufacturers have also been taking considerable quantities. Current quotations :—

Soft foreign (prompt) : Wednesday, £26 2s. 6d. ; Thursday, £26 ; Friday, £25 17s. 6d. ; Monday, £25 15s. ; Tuesday, £25 12s. 6d.

Company News.

Consett Spanish Ore Company, Limited.—Final dividend, 1s. per share.

Hadfields, Limited.—Interim ordinary dividend, 6d. per share, free of tax.

Consett Iron Company, Limited.—Final ordinary dividend, 4 per cent., free of tax.

National Gas Engine Company, Limited.—Interim ordinary dividend, 7½ per cent. per annum.

Ludlow Brothers (1913), Limited.—Interim dividend on preference, 6 per cent. per annum, less tax.

E. G. Wrigley & Company, Limited.—Directors state that there is £48,000 which they consider desirable to write off stock.

Herbert Morris, Limited.—Half-year's dividend on 6 per cent. (less tax) and 5 per cent. (free of tax) cumulative preference shares.

Sutton Ironworks, Limited, 75, Evershot Road, Stroud Green, London, N.—Capital £2,000. Directors : J. W. Abraham, F. G. Small, and E. H. Tustain.

Samuel Heath & Sons, Limited.—Profit, £10,423 ; brought forward, £14,568 ; available, £24,991 ; final ordinary dividend, 5 per cent., free of tax ; carry forward, £18,316.

Parkinson & W. and B. Cowan, Limited.—Net profit, £30,392 ; brought forward, £19,731 ; final dividend, 5½ per cent., making 8 per cent. for year ; benevolent fund, £600 ; carried forward, £2,706.

Caton Machine Tool & Engineering Company, Limited, 49, Waterloo Street, Leeds.—Capital £4,000 in £1 shares (1,000 preference, 2,000 ordinary, and 1,000 deferred ordinary). Directors : C. H. Caton and J. W. Rawling, Junr.

Wrentmores Amalgamated Engineering & Construction Company, Limited.—Capital £12,500 in 10,000 12½ per cent. cumulative preference of £1 and 50,000 founders' of 1s. each. Directors : Lt.-Col. C. H. Versturme-Bunbury and Dmitri Tchernine.

Vivian D. Llewellyn & Company, Limited, 9-10, Western Mail Chambers, Cardiff.—Capital £500 in £1 shares, to take over the business of an electrician, engineer, etc., carried on by Vivian D. Llewellyn. Permanent directors : F. Thompson and V. D. Llewellyn.

Warner & Company, Limited.—Profit, £11,122 ; appreciation in value of investments, £5,207 ; brought forward, £1,727 ; balance, £18,056 ; ordinary dividend, 20 per cent. (less tax), making 22½ per cent. for year ; depreciation (property, plant, etc.), £1,000 ; carried forward, £1,880.

R. & W. Hawthorn, Leslie and Company, Limited.—Depreciation, etc., £29.480 ; available balance, £203,427 ; interim dividend, 6d. per share, free of tax, £17,913 ; final dividend, 1s. 6d. per share, free of tax, £53,741 ; future extensions and improvements of plant, etc., £45,268 ; reserve fund, £60,000 ; carry forward, £31,503.

Normanby Iron Works Company, Limited.—Interest received and other income, £14,775 ; debenture stock interest, £2,263 ; directors' fees, £1,234 ; brought forward from last year, £1,346 ; preference dividend, 6 per cent. for year, £3,600 ; interim ordinary dividend, 6 per cent., £3,000 ; balance, £5,423 ; equalisation of dividend account, £1,000 ; final ordinary dividend, 6 per cent., making 12 per cent. for year, £3.600 ; carried forward, £823.

Telephone : 21, Penistone. Telegrams : "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING PLUMBAGO CORE GUM WHITE DUST COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	64	12	6
Three months	64	15	0
Electrolytic	71	0	0
Tough	66	10	0
Best selected	66	10	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	15	0
Do. Aug.	71	15	0
Do. Sept.	71	15	0
Ingot bars	71	10	0
H.C. wire rods	76	0	0
Off. aver. cash, July	63	3	7 3/4
Do. 3 mths., July	63	10	5 1/4
Do. Settlement July	63	3	2 1/4
Do. Electro, July	71	0	0
Do. B.S., July	67	0	0
Aver. spot price, copper, July	63	2	6
Do. Electro, July	71	13	7

Solid drawn tubes .. £3 1/2d.
Brazed tubes .. .. £3 1/2d.
Wire .. .. .. 10 1/2d.
Yellow metal rods .. 6 1/2d.
Do. 4x4 Squares .. 8 1/2d.
Do. 4x3 Sheets .. 9 1/2d.

BRASS.

Solid drawn tubes .. 11 1/2d.
Brazed tubes .. .. 13d.
Rods, drawn .. .. 10 1/2d.
Rods, extruded or rolled 6 1/2d.
Sheets to 10 w.g. .. 9 1/2d.
Wire .. .. .. 9 1/2d.
Rolled metal .. 9 1/2d.

TIN.

	£	s	d.
Standard cash	162	15	0
Three Months	162	15	0
English	162	15	0
Bars	164	10	0
Chinese	161	0	0
Straits	163	5	0
Australian	163	5	0
Eastern	164	16	0
Banca	162	12	6
Off. aver ,cash July	156	4	4 1/2
Do. 3 mths. July	156	14	5 1/2
Do. Sttlment July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

	£	s	d.
Ordinary	31	10	0
Remelted	29	5	0
Hard	23	0	0
Electro 99.9	35	10	0
English	31	7	6
India	23	10	0
Prime Western	31	5	0
Zinc dust	45	0	0
Zinc ashes	8	0	0
Off. aver., July	28	18	5 1/2
Aver., spot, July	29	0	10 1/2

LEAD.

	£	s	d.
Soft foreign ppt	25	12	6
English	26	15	0
Off. average, July	24	6	11 1/2
Average spot, July	24	17	4 1/2

ZINC SHEETS.

	£	s	d.
Zinc sheets, English	36	0	0
Do. V.M. ex. whf	36	0	0
Dutch	36	0	0
Rods	41	0	0
Boiler plates	34	0	0
Battery plates	34	10	0

ANTIMONY.

	£	s	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	24	5	0
Crude	14	10	0

QUICKSILVER.

Quicksilver £11 5 0 to £11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s	d.
Ferro-silicon—			
45/50%	13	0	0
75%	23	0	0

Ferro-vanadium—
35/40% 17/6 to 17/9 lb. va.
Ferro-molybdenum—
70/75% 6/6 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £20
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% .. .. 1/8 lb.
Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23
Ferro-chrome—
Max. 2% car. .. £65
Max. 1% car. .. £75
Max. 0.70% car. .. £90
67/70%, carbonless 1/8 lb.
Nickel—99%, cubes or pellets .. £155
Cobalt metal—98/99% 10/6 lb.
Aluminium—98/99% £100
Metallic Chromium—
96/98% .. .. 5/- lb
Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10
Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under 1/4 in. to 1/2 in. 3d. lb.
Flats under 1 in. by 1/4 in. to 1/2 in. by 1/4 in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d
Per lb. net, d/d steel makers' works.

SCRAP

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	7	6	3	15	0
Bundled steel & shearings	2	18	0	3	7	6
Mixed iron & steel	2	17	0	3	5	0
Heavy cast iron	3	7	6	3	15	0
Good machinery for foundries		4	0	0		
Cleveland—						
Heavy steel		3	2	6		
Steel turnings		2	5	0		
Cast-iron borings		2	5	0		
Heavy forge		3	12	6		
Bushelled scrap		3	2	6		
Cast-iron scrap		3	19	6		
Lancashire—						
Cast iron scrap		4	0	0		
Heavy wrought		3	10	0		
Steel turnings		2	2	6		
London—						
Copper (clean)		55	10	0		
Brass (clean)		30	0	0		
Lead (less usual draft)		21	0	0		
Tea lead		19	0	0		
Zinc		17	0	0		
New aluminium cuttings		65	0	0		
Brazier copper		46	10	0		
Gun metal		40	0	0		
Hollow pewter		120	0	0		
Shaped black pewter		70	0	0		

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	88/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	94/-
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	100/-
„ No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	104/2
W.C. hematite	107/6

All d/d in the district.

Lancashire (d/d eq. Man.) —	
Derby forge	—
„ foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (crown)	£10 10 to £12		
Angles	£11 to £12	10	0
Tees to 3 united ins.	£11 10 to 13	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, 1/2 in. × 4 in.	20	10	0
Steel—			
Ship plates	10	0	0
Boiler plates	13	10	0
Chequer plates	10	10	0
Angles	9	10	0
Tees	10	10	0
Channels	8	15	0
Joists	10	0	0
Rounds & squares 3-in. to 5 1/2 in.	10	10	0
Rounds, under 3in. to 1/2 in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1 1/2 in.	8	10	0
Rails, heavy	9	10	0
Fishplates	14	10	0
Hoops	12	0	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	0	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, 1/2 in. dia	14	0	0
Billets, soft	7 0 0 to 7	7	6
Billets, hard	8	0	0
Sheet bars	7 5 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb basis.
Strip	1 3
Sheet	1 3 1/2
Wire	1 3 1/2
Rods	1 2 1/2
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5 1/2 to 1/11 1/2
To 15 in. wide	1/6 1/2 to 2/0 1/2
To 18 in. wide	1/7 1/2 to 2/1 1/2
To 21 in. wide	1/8 1/2 to 2/2 1/2
To 25 in. wide	1/9 1/2 to 2/3 1/2
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8

Wire round—
3/0 to 10. G. .. 1/8 1/2 to 2/3 1/2
with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	27.64
No. 2 foundry Valley	24.00
No. 2 foundry, Birm.	18.00
Basic	25.96
Bessemer	26.77
Malleable	26.46
Grey forge	25.27
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	1.92
Steel bars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.70
Skelp, sheared steel	1.70
Steel hoops	2.50
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	32/6
„ furnace	22/6
Durham & North. foundry	28/-
„ furnace	22/6
Other Districts, foundry	27/6
„ furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices are now free.
Water	50%	
Steam	45%	

TINPLATES.

I.C. Cokes,	20×14, box	19/9
„	28×20, „	39/3
„	20×10, „	27/6
„	18¾×14, „	19/9
I X.	„	45/-
I.X.X.	„	51/-
F.C.B.Y.	21×13⅝ „	37/3
C.V.B.G.	16½×15, „	35/-
I.C.W.	20×14, „	17/11½
„	28×20, „	33/7½
„	20×10, „	23/6
„	18¾×14, „	17/3
Terneplates,	28×20. „	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
July 26	63	7	6	No change	
„ 27	63	12	6	inc.	5/-
„ 28	63	17	6	„	5/-
„ 31	64	5	0	„	7/6
Aug. 1	64	12	6	„	7/6

Electrolytic Copper.

July 26	70	10	0	No change	
„ 27	70	10	0	„	
„ 28	70	10	0	„	
„ 31	71	0	0	inc.	10/-
Aug. 1	71	0	0	No change	

Standard Tin (cash).

July 26	160	5	0	inc.	40/-
„ 27	162	15	0	„	50/-
„ 28	161	10	0	dec.	25/-
„ 31	162	10	0	inc.	20/-
Aug. 1	162	15	0	„	5/-

Tin (English ingots)

July 26	160	0	0	inc.	40/-
July 27	162	15	0	inc.	55/-
„ 28	161	10	0	dec.	25/-
„ 31	162	10	0	inc.	20/-
Aug. 1	162	15	0	„	5/-

Zinc Sheets (English).

July 26	36	0	0	No change	
„ 27	36	0	0	„	
„ 28	36	0	0	„	
„ 31	36	0	0	„	
Aug. 1	36	0	0	„	

Spelter (ordinary).

July 26	29	17	6	inc.	2/6
„ 27	30	7	6	„	10/-
„ 28	30	10	0	„	2/6
„ 31	31	0	0	„	10/-
Aug. 1	31	10	0	„	10/-

Lead (English)

July 26	26	15	0	dec.	5/-
„ 27	27	0	0	No change	
„ 28	27	0	0	„	
„ 31	27	0	0	„	
Aug. 1	26	15	0	dec.	5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

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BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

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COX'S BUILDINGS, KARACHI.

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SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ROYAL EXCHANGE, MIDDLESBROUGH.
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SITUATIONS VACANT AND WANTED.

MOULDER, 38, would like a change, home or abroad, as FOREMAN, or in charge of apprentices. Experienced in Engineering, Railway Work, Locomotive, Moulding Machines, etc.—Apply to Box 220, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

INDIA.—Assistant Colliery Manager required, on five years' agreement; Rs. 650, Rs. 675, Rs. 700, Rs. 725, Rs. 750 per month, respectively; must hold first-class Colliery Manager's Certificate.—Write, stating age, full particulars, experience, etc., to "Colliery Manager," c/o Deacon's, Leadenhall Street, E.C.3.

PARTNERSHIP OR POST REQUIRED.

PATTERNS OR FOUNDING.

Estimates, Schedules, Weights, Costs, Patterns, Drawings and Works Sketches, Design of Plant, Design of Gear for Moulding Machines, Sprays, Plates, etc. Methods for Mass Production, Gauges, Snags, Prevention of waste, Machine shop practice. Sources of new work. Experience in Railway, Motor, Electric, Machine Tool and General Castings. Technical correspondence. Testing. Marking out. Excellent references. Guarantees. Terminating 3½ years as Technical Chief and Foreman for the Wycliffe Foundry Company, Limited, Lutterworth.

Walter Stanley.

Gilmorton Road, Lutterworth, Leicestershire.

MACHINERY.

FOR SALE.

160-kw. 3-phase Generating Set, by Scott & Mountain, Compound Engine, direct coupled to 3-phase Alternator, 550 volts per phase, 40 cycles, 300 revs. Powerful Electric Winch, drum 3 ft. 6 in. dia., 3 ft. long, Motor 450 amps., 100 volts, 520 revs., by Clarke, Chapman & Company, Limited. 100 b.h.p. 3-phase Slip Ring Motor, ventilated type, 50 periods, 200 volts, 575 revs., by British Thomson Houston Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cyls., 26 in. stroke, by Marshall Sons & Company, Limited. Two Twin Spindle Vertical Boring, Drilling, and Tapping Machines, by D. & J. Tullis, 2¾ in. spindle, T-slotted table working surface, 5 ft. 6 in. x 4 ft. Horizontal Boring Machine, by the Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Worthington Horizontal Duplex Pump, 14 in. x 12 in. x 10 in., 10 in. suction, 8 in. delivery. Surface Condensing Plant, by F. Pearn & Company, 10 in. and 16 in. steam cyls., 12 in. stroke, air pump 18 in., circulating pump 12¾ in., surface area 1,200 ft. 12 in. stroke Shaping Machine, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

CUPOLA, 3-ton per hour; Staging, Fan, Hoist complete; made by Constructional Engineering Company. Seen working; replacing with larger plant; cheap immediate clearance.—Box 236, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY FOR SALE.

NINE nearly new 5-ton Hopper Wagons, Standard Gauge, Steel Plate Hoppers; Manning Wardell Locomotive, 9in. Cylinders; two very fine three-throw Hydraulic Pumps, 4½in. rams; 4in. Electric-driven Centrifugal Pump by Gwynnes, 220 volts d.c.; 55-h.p. Horizontal Ruston Crude Oil Engine, latest type.—Full details, Harry H. Gardam & Co, Limited, Staines.

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By direction of the Right Hon. the Viscount Hood.

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Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining

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lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

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MISCELLANEOUS.

NORTHAMPTON IRON ORE.—For sale, by order of Mortgagees, Farm containing 238 acres, valuable bed of Ironstone believed to exist thereunder, land adjoining worked. Above Farm key position to railway and adjoining land. Price freehold (cheap), £12,000.—Apply to Messrs. Merry & Son, Auctioneers, Northampton.

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3 Morgan tilting furnaces, 300 lb. capacity, gas fired, excellent order **£45** each.

6 Morgan tilting furnaces, 400 lb. capacity, coke fired, excellent order **£80** each.

One Sand Blast Barrel, 3 ft. dia. 4 ft. long, self contained ... ... **£160** each.

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